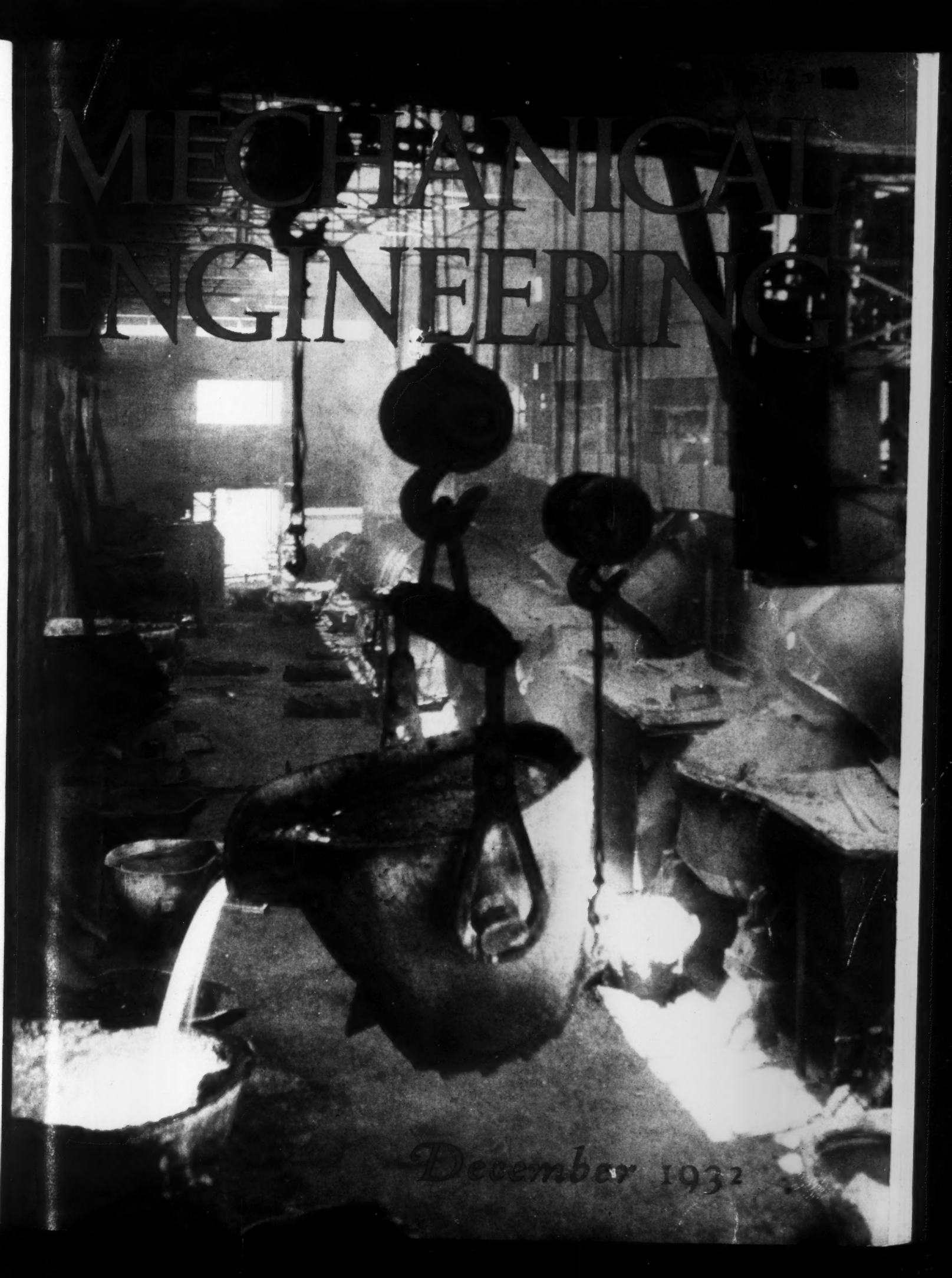
MECHANICAL ENGINEERING



December 1932

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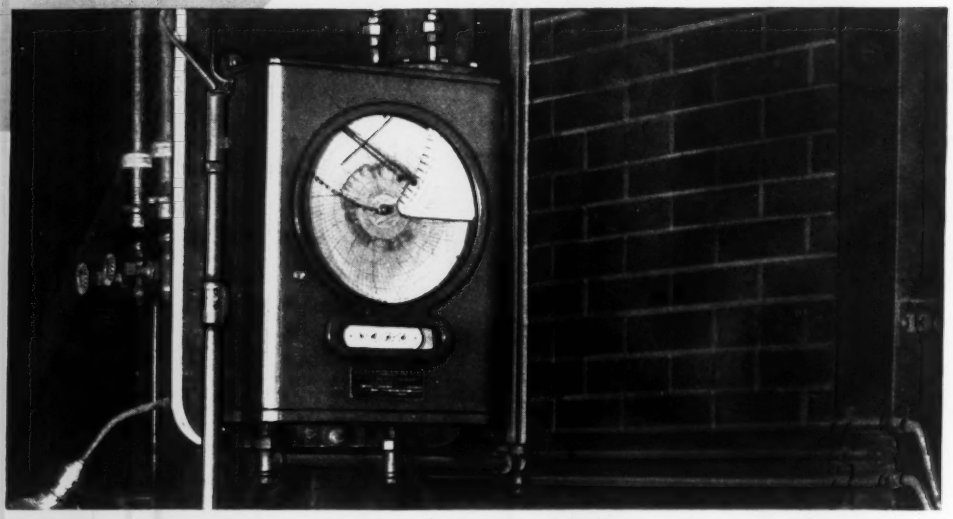

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MECHANICAL ENGINEERING

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VOLUME 54 NUMBER 12

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FOR THE LARGER VIEW

AERIAL PHOTOGRAPH, SHOWING 7200 SQUARE MILES OF THE EARTH'S SURFACE, WITH MT. SHASTA 331 MILES AWAY

FOR the past year MECHANICAL ENGINEERING has been publishing an increasing number of articles devoted to the larger view that brings economic and social relationships within the vision of engineering. It has been asserted, and there has been none to deny it, that except as engineering serves the purposes of men and the progress of civilization, it is nothing; and it has been implied, if not definitely so stated, that engineers who fail to appreciate the significance of these relationships are caught in the backwater of progressive flow where they drift aimlessly, without aid or hindrance to the forward rush of the stream. A preoccupation with technological details that blinds men to this larger view and confines them to these backwaters has been condemned in the hope that they may be drawn into the middle of the stream of modern progress with its treacherous rapids, its thundering falls, and its powerful, deep-bedded, and persistent current.

In pursuing its editorial policy MECHANICAL ENGINEERING has tried to be consistent with the ideals of those who founded The American Society of Mechanical Engineers, and with those of such great leaders as Robert Henry Thurston, Henry R. Towne, Frederick W. Taylor, and Henry Laurence Gantt who had the larger view, and who made themselves, and this Society, famous for a liberal interpretation of the engineer's function in the modern world. It is true that the times have turned men's minds to the attention of social and economic problems because the task of readjusting views in those fields and of reevaluating principles, techniques, and purposes is one of common necessity. But it is also true that, fearful of letting contributors deliver themselves of ideas that do violence to traditional philosophies, we might have sidestepped the issue by pleading that the interests of mechanical engineers are primarily in technology, or have consented to publish nothing but safely conventional dogma. As it has happened, we have given a hearing to any one who had a sincerely and logically expressed view on matters that were sufficiently close to engineering interests to make them appropriate. And we have also, subject to some limitations of space available, printed what comments on the published articles our readers have offered.

This policy, we hold, is reasonable and correct. The magazine of a professional society should lead, not follow; it should affirm the aspirations of engineers, not record their routine acts. It should strive for breadth and acuity of vision, and shun intellectual myopia and microscopy. Its orthodoxy should be neither stupid nor servile; and its heterodoxy should be tempered with tolerance and tact. The ancient triad—the good, the true, the beautiful—still serves to measure human achievement and the satisfactions for which men strive. Who, more than engineers, have provided material benefits that are good, or who seek more earnestly and prize more highly that which is true, or have it within their power to release those enslaved by toil for the appreciation of the beautiful? What more useful task can a professional magazine perform than to see that these three are not forgotten? To insist that its readers shall concern themselves with values as well as things, that they shall appreciate the dynamic properties of social progress as well as the static principles of physical law, and that they shall not too blindly confuse causes with effects and give heed to the future effects of present actions, are some of the ways whereby MECHANICAL ENGINEERING tries to present the larger view.

Lest our readers, who may have lifted a disapproving eyebrow at the cover on last month's MECHANICAL ENGI-

NEERING, should feel that we are laying inappropriate laurels on the brow of demos, we shrink back once again into the murk of Vulcan's forge that is engineering's most accustomed atmosphere, and portray this month a more familiar scene. In this smelter, through whose smoke and dust the sun struggles to outshine the radiance of molten copper, there is closer union with that mythical progenitor of all engineers, Tubal-Cain, the artificer in brass, with flesh wasted by the vapor of fire and eye blinded with the heat of the furnace. If the engineer finds himself more at home here, let us remind him that the world is outside. From the outside comes the dull ore, and to the outer world go the shining ingots. Men supply him, and he supplies other men. Without them he is nothing, and his craftsmanship is useless. Except as it serves human ends, as it has always done so magnificently, engineering exists to no purpose. And because it is so powerful an instrument for good, and not forgetting its potentialities for evil in the hands of blind or vicious men, it needs direction and control, based on a sympathetic understanding of great tides of human progress. Behind it and beyond it is humanity itself, suffering it to prosper, and desperately needing its services. Never has this great need laid a greater obligation on engineers to seek the larger view.

AN UNUSUAL variety of subjects treated in this month's MECHANICAL ENGINEERING bears witness to the larger view of professional interest. It will be recalled that in MECHANICAL ENGINEERING for March, 1929, Alford and Hannum explained the efficacy of the so-called kilo man-hour as a basis for evaluating manufacturing operation. Since then the results of the use of this unit by the Bureau of the Census, which accumulated the statistics of four industries in terms of it, and by the authors themselves in a research on technological unemployment made for the American Engineering Council, have been studied. The leading article this month is a summary of this experience.

NUMEROUS points of view on the vexing question of public works have been expressed in MECHANICAL ENGINEERING. The report of the American Engineering Council, published in the June issue under the title of "The Balancing of Economic Forces," called attention to it and to the need for centralized public-works control. In September, David Cushman Coyle pointed out ways in which public works could be used to dampen the swings of the business cycle. In October, Harvey N. Davis had something to say for the financing of public works by bond issue, and in November, George L. Hoxie concluded his paper on this subject with the statement that "A large-scale program of Government constructions is peculiarly dangerous during a period of depression." This month E. C. Harwood discusses expenditures for new construction in general, including public works, in terms of the business cycle.

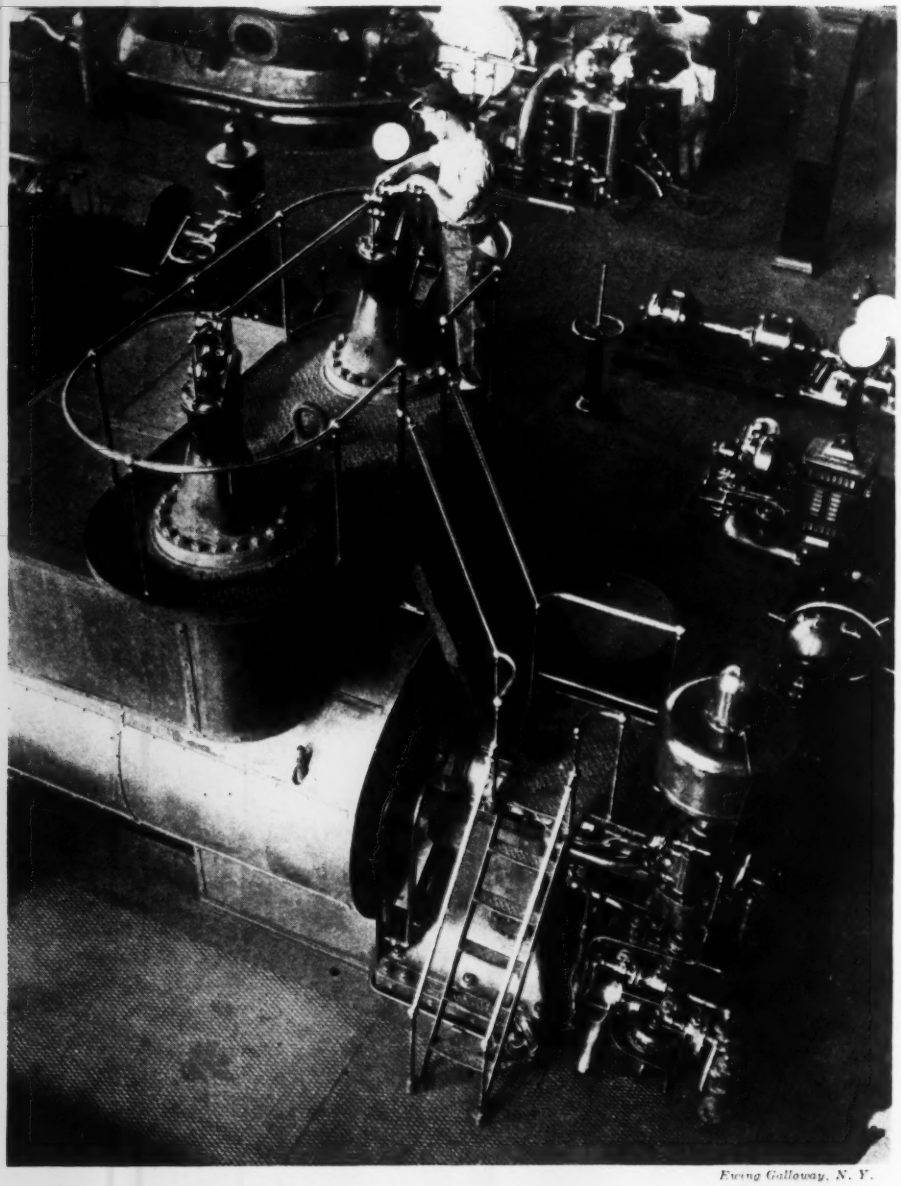
Interest in major economic problems engenders similar interest in problems relating to banks and banking. James L. Walsh points out weak spots in our present banking system in an article in this month's MECHANICAL ENGINEERING. He discusses the so-called securities affiliates of commercial banks, whose divorcement at this time he considers ill-advised, and laws relating to branch banking.

AN IMPORTANT field in which engineers share interest and obligation with architects, economists, and sociologists is that of city planning. While civil engineers may be more directly concerned, mechanical engineers will find that the problems involved are not far removed from their own. W. Russell Tylor writes in MECHANICAL ENGINEERING this month on the "Importance of the Human Factor in City Planning." The problem goes back primarily to the question of population growth and distribution and the factors that influence the building up of urban communities. It is a long-range view of an aspect of human society that affects ultimately many others.

THEN there is that ever-present and increasingly important subject of education, in which engineering societies are taking a more lively interest day by day. The A.S.M.E., for example, has recently instituted a grade of student membership, and is actively engaged in introducing the new plan into some of its student branches. In Chicago a development committee of the Armour Institute of Technology has been studying the needs of the Institute and the community it serves, and has reported on a plan which the chairman, James D. Cunningham, describes in this month's MECHANICAL ENGINEERING.

And finally, a review of developments and trends in mechanical engineering, prepared by the editorial staff and based on the annual progress reports of the A.S.M.E. Professional Divisions, and other sources, gives a brief summary of the year's activities.

ON THE opposite page is a single aerial photograph taken in January, 1932, by Capt. A. W. Stevens, Chief of the Aerial Photographic Unit, Wright Field, while he was flying at an altitude of 23,000 feet. In the distance is Mt. Shasta, 331 miles from the camera, making this, it is said, the longest-range photograph ever obtained. In one exposure have been pictured 7200 square miles, the largest amount of the earth's surface to have been caught in a single photograph up to that time. It is said that the negative was made from a point more than 100 miles beyond the place where Mt. Shasta was visible with unaided vision.



Ewing Galloway, N. Y.

The Hell Gate Plant of the United Electric Light and Power Company, New York. For the control of machinery, engineers have developed sensitive and automatic devices. Similar controls are sorely needed to regulate the fluctuations of economic machinery.

Measuring OPERATING PERFORMANCE *by the* KILO MAN-HOUR

Particulars Regarding the Kmh System, and Findings Bearing Upon the Present Industrial Situation

By L. P. ALFORD[1] and J. E. HANNUM[2]

TO MAKE full use of a method of measuring or evaluating operating performance in industry, it is necessary that a unit of measurement and its application yield facts capable of being interpreted and used for purposes of control. Many units and methods have been developed for this general purpose, including operating, cost, and financial ratios; turnovers, percentages, rates and ratings, experiential factors, comparisons, and efficiencies. A substantially complete list would probably contain a few hundred such items. This comparatively large number indicates the absence of anything like general acceptance of any particular units or methods.

The situation thus presented prompted the authors to undertake a search for a basis of evaluating industrial operating performance. The study finally yielded the kilo man-hour (kmh) system. The results and findings of this effort, which has continued over nearly five years, have been reported to The American Society of Mechanical Engineers in two papers: "A Basis for Evaluating Manufacturing Operation" (1928); and "Applications of the Kmh Method of Analyzing Manufacturing Operation" (1932). The primary data of the first study represented nearly three and one-half billion man-hours worked by nearly two and one-half million industrial employees. The data in the second paper have a coverage of 95 per cent for three industries, 25 per cent for a fourth, and a general coverage of one sixty-fifth of the total number of industrial workers employed in 1929. Thus each study is a major assay, utilizing a large volume of industrial statistics.

This article reviews the subject-matter of these two papers and presents some of the findings which have to do with present-day industrial conditions. In the main, the treatment is restricted to a showing of the facts. Interpretation, explanation, and assignment of causes for the conditions revealed more properly belong to those who are actually engaged with operating responsibilities in the several industries from which information has been drawn.

Briefly stated, the kmh system for evaluating industrial operating performance is based on the theory of control of rates, that is, if the rates of expenditure for labor, material, and expense factors of production are controlled, the total expenditure is controlled. The base of the rates, or denominator of the principal ratio fractions, is the man-hour, a factor common in all industry, and permitting a maximum degree of comparison of results. For convenience only, this base is taken as 1000 man-hours, or a kilo man-hour (kmh). This unit has given its name to the system.

The possibilities of the method for revealing pertinent facts are indicated by a few findings which have a bearing upon the present industrial situation. They show rates of production, weekly working times, wages paid, expenditures for supervision, annual working times for most favorable operating performance, optimum size of plant, selling value of product, and percentage of profit.

INDUSTRIAL PRODUCTIVITY

Engineers have often commented upon the wide differences in the productivity, or rate of production, of different plants in the same industry. The implication is that those with low rates should be upgraded to the level of those with high rates. Kmh analysis accentuates such facts.

For blast furnaces, the range of rates of production was found to be from 145 tons per kmh for a group of 9 plants to 1313 tons per kmh for a group of 7 plants. The ratio of these rates is 1:9.

For petroleum refining the ratio of lowest to highest rate of production is more startling, being 1:224. A group of 9 refineries process 633 barrels of crude petroleum per kmh, and a group of 3 refineries process 141,829 barrels per kmh.

In lumber manufacturing the returns from 305 concerns were analyzed. A group of 40 establishments had a rate of production of 13 M board feet per kmh. Another group of 16 establishments had a rate of 173 M board

[1] Vice-President, Ronald Press Co., New York, N. Y. Mem. A.S.M.E.
[2] Editor, Engineering Index, The American Society of Mechanical Engineers, New York, N. Y. Assoc-Mem. A.S.M.E.

feet per kmh, giving a ratio of lowest rate to highest rate of 1:13.

WORKING HOURS

One of the findings in regard to changes in productive hours seems to be of especial significance. "The concerns which showed a continuous increase in the kmh rate of production from 1923 to 1931 reduced, on an average, the number of kmh per unit of product by 31 per cent. That is, if the working force of 1923 had remained unchanged, the amount of product turned out in a 35-hour week in 1931 would have been the same as was produced in a 51-hour week in 1923." And further, 58 per cent of the industrial concerns studied had a higher kmh rate of production in 1931 than in 1928.

It may be implied from these findings that: (1) In well-managed concerns, productivity increases during periods of depression; and (2) that many workers who were employed up to the beginning of the present business depression will not be needed in their former or similar occupations, even when the physical volume of product is again equal to that turned out in 1929, unless industry operates generally on a much shorter work week. The surplus of industrial labor at present levels of productivity is easily reckoned on this basis as some 4,000,000 persons.

The annual rate of increase in productivity in well-managed concerns is of the order of 4 per cent, and the process appears to be continuous.

In spite of the agitation against the long working turn and in favor of the 8-hour day, the range of number of hours worked per week in the four industries studied extensively is not only very wide, but the high value in each case indicates a very long work week. The ranges of hours per week are: in Blast-Furnace Operation, from 33.8 to 83.4 hours; in Machine-Tool Building, 37.3 to 57; in Petroleum Refining, 31.7 to 66.5; in Lumber Manufacturing, 27.9 to 57.6. The most favorable, or optimum, range of length of work week was also determined on the basis of nine kmh factors. For three of the industries the lower optimum limit is practically the same as the minimum for the industry; for the fourth it is somewhat higher. In all four industries the upper limit of the optimum range is substantially lower than the maximum. The optimum ranges of the work week, expressed in hours, are: for Blast-Furnace Operation, from 34.8 to 50.2; for Machine-Tool Building, from 37.1 to 47.3; for Petroleum Refining, from 47 to 54; for Lumber Manufacturing, from 30.8 to 50.8. The portion of the total kmh plant capacity of each industry that is within the optimum range is: Blast-Furnace Operation, 26.5 per cent; Machine-Tool Building, 40.9 per cent; Petroleum Refining, 72.2 per cent; Lumber Manufacturing, 64.0 per cent.

INDUSTRIAL WAGES

Following the business depression of 1921–1922 the doctrine of high wages was generally accepted by industrialists and labor leaders. During the present depression it has been generally discredited; wage rates have been cut in all industries and localities. Our studies, based on records from 1925 to 1929, show that "high wages accompany high operating performance" in four industries: Blast-Furnace Operation, Machine-Tool Building, Petroleum Refining, and Lumber Manufacturing. And further, "the highest wage rate, measured in dollars per kmh, accompanies the highest kmh operating rate, and the lowest wage rate accompanies the lowest operating rate."

The range of wages paid per kmh is wide in three of the industries: for Blast-Furnace Operation, from $198, the lowest, to $1016, the highest; for Petroleum Refining, from $242 to $1067; for Lumber Manufacturing, from $149 to $1143. In Machine-Tool Building the range is narrower, being from $464, the lowest, to $927, the highest. It will be noticed that the highest values are in substantial agreement for all four industries, being, respectively, $1.016, $1.067, $1.143, and $0.927 per hour.

OPTIMUM SIZE OF PLANT

The opinion is frequently expressed that there is a most favorable, or optimum, size of manufacturing plant to produce any particular article or commodity. Our first study indicated that in many industries the smallest plant investigated had a higher rate of production than those that were larger. To quote

> The smallest company has a higher rate of production than the largest in 35 industries.
>
> The smallest company has a lower rate of production than the largest in 18 industries.
>
> The smallest company has the highest rate of production in 16 industries, and a high rate in 5 industries.
>
> The smallest company has the lowest rate of production in 6 industries, and a low rate in 16 industries.

These comparisons indicate that the optimum size of plant from the productivity viewpoint may not be the largest.

In the second study, the optimum range of size of plant, expressed in kmh worked per year, was determined for each of the four industries. The figures, which indicate quite small plants and support the theory of decentralization of industry, are:

Industry	Optimum kmh per year
Blast-furnace operation	270–640
Machine-tool building	30– 80
Petroleum refining	40–140
Lumber manufacturing	50–300

The kmh capacity of the plants operating within these optimum ranges is a comparatively small part of the total kmh capacity of each industry. The percentages are: in Blast-Furnace Operation, 33.8 per cent; in Machine-Tool Building, 4.5 per cent; in Petroleum Refining, 7.7 per cent; in Lumber Manufacturing, 15.2 per cent.

SELLING VALUES AND PROFITS

The kmh method offers a means to relate selling value of product with wages paid in its production and with net profit made from its manufacture. In general, high selling value is associated with a high rate of wages and with a high percentage of net profit. These relation-

ships are best shown by two tabulations from our first paper. In each the data year is the calendar year 1925.

Industry	Selling value of product, dollars per kmh	Wages, dollars per kmh
Automobiles	6410	683
Manufactured ice	4240	796
Explosives	3950	437
Paper and pulp	2825	465
Portland cement	2700	483
Carpets and rugs	2640	605
Lumber	2190	702
Firebrick	1730	600
Rayon	1680	440
Cast-iron pipe	1350	372
Cotton fabrics	1320	273
Leather shoes	1120	272

Here the selling values per kmh are arranged in a descending series, and the wages per kmh in a similar, though not so perfect, one.

The relationship between selling value and net profit is now shown.

Industrial group	Percentage of net profit, 1925	Constituent-product groups	Selling value of product, dollars per kmh
Leather	3·26	Leather shoes	1120
Textiles	4·11	Yarn and thread	548
		Knitted underwear	1115
		Cotton fabrics	1320
		Rope and twine	1330
		Hosiery	1390
		Knitted sweaters	1447
Lumber	5·38	Sash and doors	584
		Millwork—doors	1160
		Furniture	1440
		Woodenware	2070
		Lumber	2190
Paper	6·97	Writing paper	1000
		Book paper	1950
		Boxboard	2180
		Wrapping paper	2190
		Paper and pulp	2825
		Newsprint	3020
Printing	7·73	Commercial printing	2370
Rubber	8·98	Rubber tires	5080
Chemicals	10·15	Explosives	3950
		By-product coke	4700
		Lead products	6030
		Petroleum products	7570
		Soap	7990
		Paint, varnish, and lacquer	9400

Here the column of percentages of net profit forms an ascending series, and the corresponding selling values per kmh a similar, though not so perfect, array.

TYPICAL KMH UNITS

In the light of the foregoing examples of the usefulness of the kmh in analyzing industrial statistics, let us examine the reasons for its great adaptability and further uses to which it may be put. The kmh was selected as the base factor, or common denominator of rates, because it satisfies four essential requirements. It is

Measurable by an established unit
Universal in use in industry
Easy to handle in computation
Influential in its effect on industrial operation.

By its use in a coordinated system, numerous factors in industrial operation may be established, including quantities and costs, rates of flow of quantities and costs, and rates of change of rates. Representative industrial operating rates are given in the following list, which, however, is not intended to be complete.

Factor	Kmh rate
Costs:	
Fuel and electric energy	
Manufacturing cost	
Materials cost	
Overhead (burden) charges	
Prime cost	Dollars per kmh
Salaries	
Supervision	
Value added by manufacture	
Wages	
Fixed capital investment:	
Land	
Buildings	Dollars per kmh
Equipment	
Personnel and employment:	
Accident frequency	Number of lost-time accidents per kmh
Accident severity	Number of working hours lost per 1000 kmh
Labor utilization	Average number of workers employed per unit of product or Quantity of product output per worker
Labor application or labor time	Man-hours worked per worker
Time utilization	Man-hours worked per unit of product
Working-force requirement	Average number of workers employed per kmh
Labor stability	Total number of workers employed per kmh
Primary power	Horsepower utilized per kmh or Kilowatts utilized per kmh
Productivity	Physical volume of product per kmh
Profit:	
Manufacturing profit	
Selling profit	Dollars per kmh
Net profit	
Selling price	Dollars per kmh

THE KMH IN CLASSIFICATION

The kmh system also provides means for the classification of the factors in operating performance. Its adaptability for this purpose is important, inasmuch as the systematic organization of information is the first step in the use of the system. Operating data for four industries, grouped into four classifications, may be used to illustrate this point. The four classifications are as follows:

1 Classifications into groups of quantities by each of the following quantities:
   - Wage earners
   - Kilo man-hours
   - Salaries
   - Wages
   - Cost of materials
   - Cost of fuel and purchased electric energy
   - Value of products
   - Value added by manufacture
   - Quantity of products
   - Horsepower

2 Classifications of kmh rates derived from the quantities in the first classification

3 Classifications into groups of quantities by each of the following kmh rates:

Wage earners per kmh
Man-hours worked per wage earner
Salaries per kmh
Wages per kmh
Cost of materials per kmh
Cost of fuel and purchased electric energy per kmh
Value of products per kmh
Value added by manufacture per kmh
Quantity of products per kmh
Horsepower per kmh.

4 Classifications of kmh rates derived from the quantities in the third classification.

Useful figures for the analysis of the data are the kmh rates in the fourth classification. Condensed tables, giving the classifications by one quantity and by the rates derived therefrom, for one industry, will indicate the value of the kmh system for classification purposes.

Unclassified total data for the blast-furnace industry in 1929 are:

Number of establishments	86
Number of wage earners	23,100
Number of kilo man-hours worked	69,150
Amount paid in salaries	$6,145,484
Amount paid in wages	$39,023,530
Cost of materials	$398,657,305
Cost of fuel and purchased electric energy	$183,475,562
Value of products	$734,085,672
Value added by manufacture	$151,952,805
Number of tons of product	40,710,666
Horsepower of prime movers plus that of electric motors driven by purchased energy	2,106,050

The first classification of five quantities grouped according to the average amount of wages paid by each group, as shown in Table 1, is an example of the usual statistical analysis employed. Neither this grouping, nor the kmh rates derived from it, are particularly significant. The third classification of the same five quantities grouped according to wage rates expressed in dollars per kmh is shown in Table 2, and the average kmh rates derived from the quantities are given in Table 3. Kmh rates of the cost of supervision, of wages, of the value of product and of the quantity of product, together with the average length of the work year, are classified according to the kmh rates of wages. This classification of rates by rates, used by the authors in their papers, demonstrates the adequacy of the kmh system for the orderly arrangement of data. It will be noted that there is a progressive change in the rates from the lowest to the highest, and that the number of establishments in the groups form almost a perfect frequency curve.

Table 3 presents further evidence in support of the statements that high rates of production and value of product are associated with high rates of salaries and wages and short hours of work; whereas low rates of production and value of product accompany low rates of salaries and wages and long hours of work.

TABLE 1 CLASSIFICATION OF QUANTITIES BY A QUANTITY (IN THIS TABLE, WAGES)

Limits of groups; average amount paid as wages (dollars)	Number of establishments	Kilo man-hours	Salaries (dollars)	Wages (dollars)	Value of products (dollars)	Quantity of products (tons)
Under 100,000	7	282	18,966	74,802	1,081,170	56,811
100,000 to 199,999	19	340	29,834	149,575	2,821,243	160,875
200,000 to 399,999	29	534	45,922	303,800	5,687,785	313,635
400,000 to 599,999	7	902	94,161	463,669	9,014,610	497,298
600,000 to 799,999	9	1116	102,781	681,731	11,506,487	642,734
800,000 to 999,999	6	1421	99,584	857,062	16,403,303	924,210
1,000,000 and over	9	2262	211,719	1,369,350	27,029,575	1,483,336

TABLE 2 CLASSIFICATION OF QUANTITIES BY A KMH RATE (IN THIS TABLE, WAGES PER KMH)

Limits of groups; wage rates in dollars per kmh	Number of establishments	Kilo man-hours	Salaries (dollars)	Wages (dollars)	Value of products (dollars)	Quantity of products (tons)
Under 300	5	418	13,297	82,580	795,034	37,914
300 to 399	8	480	33,446	170,708	2,486,413	148,408
400 to 499	15	711	60,647	317,161	5,931,783	363,980
500 to 599	31	998	90,705	549,696	11,474,382	609,799
600 to 699	14	853	75,110	542,562	9,235,335	504,563
700 to 799	9	792	73,490	584,518	10,138,967	587,983
800 and over	4	637	94,229	647,611	11,247,811	653,652

TABLE 3 CLASSIFICATION OF KMH RATES BY A KMH RATE (IN THIS TABLE, WAGES PER KMH)

Limits of groups; wage rates in dollars per kmh	Number of establishments	Average length of work year in hours	Cost of supervision in dollars per kmh	Wage rate in dollars per kmh	Value of product in dollars per kmh	Productivity; tons of product per kmh
Under 300	5	3940	32	198	1,903	91
300 to 399	8	3670	70	355	5,178	309
400 to 499	15	3280	85	446	8,338	512
500 to 599	31	3100	91	551	11,501	611
600 to 699	14	2840	88	636	10,824	591
700 to 799	9	2700	93	738	12,805	743
800 and over	4	1810	148	1016	17,649	1026

ADOPTIONS OF THE KMH SYSTEM

The kmh system has had two governmental adoptions. The Report of the Committee on Technological Employment, as transmitted to the Secretary of Labor on November 14, 1931, carries this recommendation: "That the Department of Labor adopt and put into use at the earliest practical date the Alford-Hannum method for determining the influence of technological change upon employment and unemployment." The Bureau of the Census, in a supplemental return in the Census of Manufactures for 1929, secured information from four industries—Blast-Furnace Operation, Machine-Tool Building, Petroleum Refining, and Lumber Manufacturing—and submitted the data to kmh analysis. The report of the Census study—in process of publication by the Government—has been drawn upon freely in the preparation of the authors' paper of 1932 and this article.

The foregoing indicates that there exists a fundamental principle, or law, of industrial operation which the authors designate as the Law of Operating Rates, namely,

> Operating performance is controlled most directly through control of the rates of expenditure of labor, materials, and expense.

(*Continued on page 878*)

NEW YORK FINANCIAL DISTRICT—SHOWING NEW YORK STOCK EXCHANGE

Ewing Galloway, N. Y.

Strengthening Our BANKING STRUCTURE—I

Weak Spots in the Present Banking System—An Engineering Analogy—The Existing Situation—Limited Branch Banking a Desideratum

By JAMES L. WALSH[1]

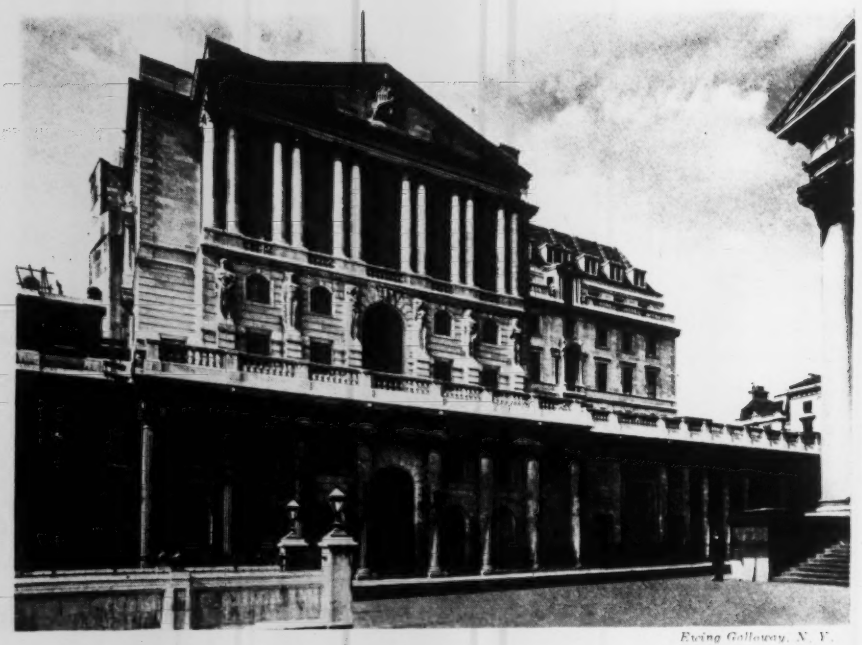
THERE is practically no way of stopping even Al Capone, if he chose to start a bank," according to the Chicago *Journal of Commerce* of November 1, 1932, which explains that, under the Illinois banking laws which control (?) the organization and operation of state banks in Illinois, "there is no investigation of any consequence to determine whether a charter should be issued or whether the needs of the community are already served, and there are practically no restrictions in the qualifications or training of the men who propose to open banks." Whether this somewhat startling remark was intended to be taken literally or not, one has an uneasy feeling that it may contain an uncomfortable measure of truth, possibly applicable to many other states in the Union.

Recalling the recent epidemic of bank closings, the ever-inquisitive engineering mind may sense a possible "cause and effect," and be tempted to pursue the subject further, in an endeavor to appraise the soundness of design of our banking structure, to ascertain inherent weaknesses if any exist, and to attempt to determine correctives if susceptible of application through legislation or otherwise. "Legislation" is an important word in banking; possibly it is *the* important word. For banks are organized and operated under the provisions of codes of law—fifty widely differing codes of law, to be exact—one for national banks, one for each of the forty-eight states of the Union, and one for the District of Columbia.

BANKS NOW OPERATE UNDER FIFTY WIDELY DIFFERING CODES OF LAW

These fifty separate and distinct banking codes, under which Americans endeavor to transact their banking business, vary greatly in minimum amount of capital required, maximum amount of loans permitted, quality of assets accepted as suitable for investment, strictness of examination prescribed, and breadth and variety of powers conferred; but they come nearest to being in complete agreement in one single respect—there is little,

[1] Executive Vice-President, Guardian Detroit Union Group, Inc., Detroit, Mich. Mem. A.S.M.E.



Ewing Galloway, N. Y.

THE BANK OF ENGLAND, LONDON

if any, restriction as to standards of training or ability on the part of managing personnel. All this may suggest to engineers of World War experience a wondering thought as to how we should have fared in 1917–18, if our forces had comprised troops organized under fifty different enlistment contracts, armed with rifles of fifty different calibers, officered under fifty different sets of authorities and responsibilities, trained under fifty different kinds of drill regulations, and with complete absence of power to remove inefficient commanders without at the same time destroying the organizations they were supposed to lead. Yet the analogy is not far-fetched.

During the Civil War and the Spanish-American War we experimented, to our sorrow, with volunteer militia organized in the several states with terms of enlistment varying from "90 days" to "the duration of the war," with officers appointed largely by the governors, who continued to exercise, throughout the war, a measure of authority over troops raised in their respective states. It was not until the grave national emergency of the World War confronted us that the sheer necessity of the situation forced an attempt to weld our forces into a single homogeneous, well-disciplined, thoroughly coordinated Army of the United States.

AN ENGINEERING ANALOGY

As a nation we learn slowly—but we do learn. As a matter of fact, the American public is already examining, with a critical eye, the heterogeneous collection of fifty different banking systems (or lack of system) and comparing its effectiveness with the single uniform banking system which prevails in other countries; in England, or in Canada, for instance.

The subject is of almost universal interest because almost every individual in the country is directly affected by tremors of the banking structure. Chambers of commerce and civilian fact-finding organizations, as well as governmental agencies, are turning up facts and drawing conclusions which should lead to necessary corrective action.

If a group of mechanical engineers should happen to be discussing a certain device or mechanism, a certain type of steam boiler, for instance, and it developed that, over a ten-year period, approximately one-third of these units had failed to function properly, the consensus would be that something was wrong with the device in question. If, then, it should further develop that, during the same period of ten years, the failure of these particular units or structures had caused a financial loss to the public in the amount of $4,332,000,000, in addition to vast sums invested by their owners, it is a fair presumption that our engineering friends would take it upon themselves to examine, analytically and dispassionately, the design of this particular device, with a view to seeing whether or not there was something inherently unsound and dangerous in its structure, or whether the device had been subjected to unusually severe abuse against which it could not reasonably be expected to stand up.

If, in warming up to the subject under discussion, it should be ascertained that while 47 per cent of the failures did occur during a three-year period characterized by conditions of unusual stress, nevertheless the remainder, or 53 per cent, of the failures occurred during a seven-year period when conditions were unusually favorable, it is reasonable to suppose that one or more of the engineers present would contend that the design itself was bad, and that the unusually severe conditions under which 47 per cent of the failures occurred served merely to emphasize and bring out into bold relief threatening conditions which should have been apparent anyway.

Then they would decide pretty promptly that "something ought to be done about it," and they would probably insist that all the energies and facilities of the engineering profession be directed toward preventing a repetition of such a tragic record of failures at such staggering cost to the public. However, we are not discussing high-pressure steam boilers, high-velocity turbines, high-speed elevators, or other devices or structures, for the safety of which the mechanical engineer has a moral responsibility to the public. We are talking about another matter in which, however, the mechanical engineer has a direct personal interest, along with 120,000,000 other Americans.

Keystone-Underwood, N. Y.

THE BANK OF FRANCE, PARIS

CRISIS NOW SAFELY PASSED

Before proceeding further, perhaps it would be well to state that although a dangerous crisis was in the offing, it has now been safely passed. Emergency measures have forestalled practically all possible unfavorable contingencies. Of the devices in question still in service, all those threatened with failure have been strengthened by improvised I-beams, reinforcing plates, and struts, so that relatively few additional failures are to be expected. But, that hardly justifies the *status quo*.

As a matter of fact, the banking situation is now facing conditions much more favorable than the cataclysmic combination of factors which confronted America and the rest of the world about a year ago. During September and October of 1931, $750,000,000 in gold was withdrawn from the United States by foreigners within the short period of six weeks. In contrast with this condition, $300,000,000 in gold was returned to this country by foreigners during August, September, and October, 1932. A year ago, hoarding by our own citizens was threatening to strangle the economic life of the nation. Today, we can look back on a decline of hoarding in the amount of nearly $100,000,000 during the three months ended October 31, 1932. Within the same period, borrowings by reporting member banks of the Federal Reserve System show a reduction of $167,000,000, and an accumulation of excess reserves by New York City banks alone in the amount of $235,000,000.

It is too much to say that there is now no possibility of a relapse. In all frankness, some measure of danger is with us yet, and will be with us until we solve the real threat to complete economic recovery by strengthening our banking structure. To that end, the best brains we have in the United States of America should direct their energies, their clearest thinking, and their most determined action.

To put the situation in bluntest terms, approximately one-third of our banks have been closed during the past ten years, and about 20 per cent of the remainder have had to be strengthened by the National Credit Corporation or the Reconstruction Finance Corporation in order to render them fit to continue in service. In this generalization, however, there is one significant fact which might be missed by the casual observer.

From April 1, 1922, to March 31, 1932, inclusive, 9166 banks suspended operations in the United States. True, 4315 of these suspensions occurred during a period of unprecedented depression and political disturbance both here and abroad, but no less than 4851 happened during a period of prosperity such as the world had never before witnessed. Whether in times of plenty or times of panic, this would appear to be at least a prima facie indictment of the design of our banking structure, or of the units of which it is composed. However, before bringing in a true bill, perhaps it would be well to ascertain whether any other design had stood up against similar, or even worse, conditions. During the ten-year period under discussion, Great Britain experienced no banking failures, and Canada but one—in 1923. The evidence is beginning to point to faulty design.

EVIDENCE POINTING TO FAULTY DESIGN OF BANKING STRUCTURE

The engineering analogy is good as far as it goes—but it doesn't go far enough. If a steam boiler according to a certain design explodes, it is obvious that other boilers of similar design or even stronger design, located in the same power house, may have their safety threatened through physical impact, through undermining of foundations, or, possibly, through having an overload thrown upon them. All of these have their corresponding effects in the banking world. The failure of a single bank in a given community may threaten the safety of other banks through direct impact, in that part of the cash of the other banks may be wiped out in the fall of the first bank—and thus destroy them.

More probably, the remaining banks would be adversely affected through the undermining of public confidence, and no bank is stronger than the public confidence it is able to command. But here enters another destructive factor not present in our engineering analogy. If a steam boiler explodes in a distant state, the incident may well serve to direct attention to boilers built from the same design and installed in other states,

but the explosion of the first boiler will not, of itself, cause a sympathetic explosion of other boilers. All banks, however, are affected, to a certain extent, by the failure of other banks, no matter how small the closed bank, nor how far removed.

When $4,345,000,000 of depositors' funds were either temporarily tied up or permanently wiped out by reason of our 9166 bank suspensions, there was, of necessity, a liquidation, or an attempted liquidation, of a corresponding $4,345,000,000 or more of banks' "Loans and Discounts," of "Real Estate Mortgages," and of "Bonds" held in the banks' portfolios.

As successive banks suspended, and receivers were appointed, the pressure for liquidation of assets to pay off depositors increased to such a degree that the already overburdened securities markets, real-estate markets, and commodities markets ceased to be such in any sane sense of the word, and the record of transactions therein became a mere narrative of sacrifice prices obtained for distress merchandise in the shape of real estate, commodities, and securities thrown to the junk man for whatever cash they would bring.

Assume that a small bank in the South had $5000 of XYZ R.R. 4½'s of 1935, which it was compelled to sell in order to obtain funds to pay off clamoring depositors, and that the next day another closed bank, in the Far West, endeavored to sell $10,000 of the same issue. The market, of course, went off a few points. Banks in the larger financial centers, noticing repeated declines in this issue, found it advisable to dispose of blocks of $20,000 to $50,000. Further declines followed—each bank endeavoring to realize, as promptly as possible, on what appeared to be perfectly sound bonds, but on a precipitately declining market. Insurance companies holding blocks of, say, $100,000 to $500,000 became alarmed and added their fuel to the fire.

Sound banks may have continued to hold this issue in their secondary reserves, and the national-bank examiners, or representatives of the state banking department, now drop in to make a regular examination. They price a bank's bond list according to the market, and, finding a twenty-point drop in this particular issue, may direct a writing-down to the market. Repeat this performance for hundreds of bond issues, good, bad, and indifferent, and, through no act of their own, through no real lack of intrinsic value in the bonds held in their portfolios, all but the strongest banks and insurance companies may find themselves embarrassed in raising ready cash to meet the insistent demands of their depositors for their deposits, or of their policyholders for policy loans or cash-surrender values.

Thus, what starts as a minor local injury, may all too easily develop into a general infection. Accordingly, weak banks are a menace to stronger institutions, and the cycle of events set in motion by the failure, and subsequent liquidation, of weak banks is felt throughout the banking structure, not merely in terms of lack of confidence, but in tangible, computable losses evidenced in depreciation of bond portfolios, decreased margin on loans, etc.

The obvious remedy is to eliminate the weak banks, or, better still, to correct the conditions which caused or permitted them to become weak to a degree which threatened the safety of other institutions. This will be difficult, but it can be accomplished.

TWO WEAK SPOTS IN THE BANKING STRUCTURE

Disinterested opinion apparently is concentrating upon two weak spots in the banking structure. First, the existence of so-called securities affiliates of commercial banks; and, second, the absence of legal authority for strong national banks to expand throughout the state in which located, so as to absorb smaller banks which are finding it difficult to survive, and also to provide banking facilities where none now exist.

In order to remedy the first of these defects, it has been proposed that securities affiliates be absolutely divorced from national banks and from state banks which are members of the Federal Reserve System. The advantages, or disadvantages, of this proposal are principally of academic interest to one who digs into the investment-banking situation. As it stands today, the United States Government is probably the largest banking institution in the world. Including loans to foreign governments, resulting from the World War, loans to railroads, insurance companies, and banks through the Reconstruction Finance Corporation, advances for self-liquidating projects, credits based upon agricultural products, etc., Uncle Sam is today in the banking business to an extent approaching nearly $14,000,000,000. Unless he wishes to stay in the banking business permanently, these loans will have to be funded by the sale to the investing public of long-term bond issues—all this over and above his own Treasury financing program. In brief, the United States Government, directly or indirectly, faces the prospect of the largest program of issuance of securities of which the world has ever dreamed. An effective bond-distributing organization must be available in order to accomplish this.

A rough appraisal of bond issues placed with the public during 1931 indicates that the securities affiliates of commercial banks, or the bond departments of banks, accounted for more than 80 per cent of the year's distribution of bonds. Absolute divorcement of securities affiliates, or forbidding banks to engage in the securities business, would destroy this mechanism absolutely necessary in transferring the burden of indebtedness from Uncle Sam to the private investor. Over and above the Government's own requirements for long-term capital, the various states, and municipalities in the states, not to mention the railroads, the public utilities, and many industrial corporations, will be in the market for long-term funds, the placing of which cannot be much longer deferred. It is not a question of whether we are in favor or are opposed to banks having securities affiliates. We cannot scrap the existing bond-distributing mechanism until we have devised a substitute mechanism at least as effective. The immediate prospects are not encouraging for the establishment of a

system of private independent bond houses with capacity to handle the programs of refinancing and new financing which are plainly in sight.

Attention is therefore focused upon the second suggested remedy, namely, the authorization for national banks to establish branches throughout the state in which they are located.

A SUMMING UP OF THE EXISTING SITUATION

In the New York *Herald Tribune* of October 9, 1932, George E. Anderson sums up the existing situation as follows:

> The chief occasion for the rising demand of Federal bank authorities for a unified banking system is the impossibility of assimilating the national-bank system to the forty-eight diverse systems obtaining in the various states and maintain what they consider sound banking practices. Bank regulations in these states vary greatly, and in some states are stringent enough to compel sound banking. In other states charter powers of the state institutions are very broad and give the latter immense advantages in competing with the national institutions located in the same communities. Keen competition between the banks leads national institutions in such states into practices considered reprehensible by the Federal authorities, where indeed they do not directly transgress the law.

Due to legal difficulties involving questions of constitutionality, the development of a single, unified national banking system is too much to expect in the reasonably near future, but certain steps in the right direction appear to be feasible at this time, among others that of giving national banks authority to operate branches throughout the state in which they are located, regardless of restrictions of state law.

In a report of the National Industrial Conference Board, published in July, 1932, and characterized by the customary marshaling of all pertinent facts and conservatism of statement which we have come to expect from that unprejudiced organization, we find the following conclusion:

> If the test of a sound banking system is its ability to maintain its position and usefulness through economic adversity as well as prosperity, the American banking system failed signally in recent years. The failure of the banking system to function satisfactorily under conditions of business depression revealed two serious defects. First, it showed that the functional changes in the banking system that had brought it into closer relations with the security markets involved manifold risks. Second, it revealed clearly the structural weakness of a local independent unit banking system, especially the one-sided character of the burden of maintaining that system in smaller communities.

A graphic illustration of the potential danger of the present situation even to the largest and soundest metropolitan institutions and their thousands of correspondent banks, together with a constructive suggestion from a disinterested source as to a possible remedy, was set forth in a leading editorial in the New York *Herald Tribune* of June 29, 1932, as follows:

CHICAGO AND BRANCH BANKING

> The Chicago "neighborhood" banks, in sponsoring the Hull amendment, were fearful lest they be swallowed up if the Loop banks were permitted to establish branches throughout the city's environs. They might have saved themselves these apprehensions, for they have been virtually swallowed up even without such a development. Out of 224 institutions in existence in 1929, only about sixty remain. Last week the debacle of the "neighborhood" bank reached its final stage when twenty-two institutions closed their doors within four days and induced temporary runs even on some of the stronger banks in the city's Loop district.
>
> If it were the weak banks alone that had to pay it would not be so unfortunate, but when weak banks topple they undermine confidence in other institutions, with the results that we have witnessed in the case of Chicago.
>
> Chicago's record of more than 100 bank failures in the course of the past year and a half, as contrasted with thirteen in New York City, should be the clinching argument, if one were needed, for the adoption of a broad policy of state-wide branch banking throughout the United States.

The suggestion as to adoption of a "broad policy of state-wide branch banking throughout the United States" is concurred in by the Report of the Banking Committee of the Chamber of Commerce of the United States, as follows:

> Notwithstanding the problem of overcoming deep-seated prejudices in favor of the exclusive development of unit banking, your committee believes that one road to improvement of our banking situation is the carefully regulated development of branch banking. The loss of the independent status of some banks not now in a position to protect fully the safety of the bank depositor, to whose welfare all too little attention has been paid, or to furnish adequate banking facilities to their communities, would produce benefit if these banks should be converted into branches of strong banks. . . .
>
> Considerable hardship has been experienced by some communities because of the partial or complete breakdown of their banking facilities. In instances it is difficult, if not impossible, for local interests to assume the entire burden of reestablishing needed banks or to protect adequately the capital structure and deposits of existing banks. In a regrettable number of cases, also, weak national and state banks continue because no available means, in the absence of branch banking, offer to affiliate them with strong institutions. Branch banking would provide a solution to many of these problems through enabling strong, well-managed institutions to invite existing banks to combine with them and strengthen the facilities offered the public, including the establishment of such offices as might be required in outlying towns and villages.
>
> A national bank should be permitted, subject to carefully devised administrative regulations but unlimited by restrictions of state law, to establish state-wide branches; federal legislation should not deny similar powers to state member banks.

BRANCH BANKING—WHAT IT IS

When we speak of "branch banking," it is important to define accurately just what we are talking about. This is done in the following excerpt from the latest draft of the Glass Bill (Senate 4412), as modified by the Vandenberg amendment:

> SECTION 19. Paragraph (*c*) of Section 5135, of the Revised Statutes as amended, is amended to read as follows:
>
> "(*c*) A national banking association may, with the approval of the Federal Reserve Board, establish and operate new branches within the limits of the city, town, or village, or any point within the state in which said association is situated. No such association shall establish a branch outside of the city, town, or village in which it is situated unless it has a paid-in and unimpaired capital stock of not less than $500,000. Except in a city, town, or village where there is no national or state bank regularly transacting customary banking business, no such association shall establish a branch, except by taking over an existing unit bank, or an affiliate of such association."

The purpose of Section 19, as quoted above, is, fundamentally, to authorize by law the continuance of banking facilities in communities where, due to economic

reasons, a small unit bank is finding it difficult to survive; and to authorize the establishment of some sort of banking facilities in cities, towns, or villages which are now without any banking facilities whatsoever. The line of reasoning which has led the Committee on Banking and Currency of the United States Senate, and a large majority of the Senate itself, to approve the limited kind of branch banking referred to above, was clearly and comprehensively stated by Senator Arthur H. Vandenberg, of Grand Rapids, Mich., in his address in the Senate of the United States on May 12, 1932, as follows:

MR. VANDENBERG: . . . I have been one of those, and still am, who feel that the preservation of decentralized community life is absolutely essential to the preservation of the traditional American community character. I feel, furthermore, that decentralized community life is impossible without a practical degree of decentralized commercial and banking independence. . . .

But we confront a condition and not a theory today, and, even in defense of decentralized community life, situations readily may arise in which limited branch banking might be the only community salvation. Certainly it would not protect decentralized community welfare, Mr. President, to close the door on a banking facility which might prove to be the community's only way of saving the solvency of its banking resources. Branch banking might be this sole available facility. Neither does it protect decentralized community welfare to close the door on a banking facility which may be the only such facility available after all other banking facilities have failed or been withdrawn. Indeed, it might well be argued that under certain circumstances a recourse to limited branch banking may well prove to be the means of keeping alive many a decentralized community which otherwise might disintegrate through its very inability to secure any banking facilities whatsoever.

Obviously with a problem of such national importance as banking, a skilful and intelligent working out of a solution requires the sympathetic assistance of an informed public opinion. Engineers should hold an opinion on matters relating to the banking structure of our country. The activities and interests of engineers as professional men, as industrialists and managers, and as ordinary citizens are intimately bound up in the banking problem. The stability of the numerous enterprises in which engineers are interested, and the security of their personal fortunes, are bound to be affected by banking legislation now under consideration. In a subsequent article, the author will endeavor to cover the relationship between the bank and its individual and corporate depositors; the growth of certain trends in banking, and suggestions which have been made for their correction.

Ewing Galloway, N. Y.

BANK FOR INTERNATIONAL SETTLEMENTS, BASEL, SWITZERLAND

IMPORTANCE *of the* HUMAN FACTOR *in* CITY PLANNING

Problems Arising as a Stationary State of Population Is Approached

By W. RUSSELL TYLOR[1]

WHEN we think of a city, we are apt to think foremost and principally in terms of its physical structure: of its buildings, its broad and narrow streets and boulevards, its civic centers, parks, and playgrounds. City planning then becomes the concerted reordering and redirection of the outlines of this material structure in the light of some well-defined plan. Unlike social or economic planning it deals not so much with altering or adjusting fundamental institutional policies and programs of social groups so as to insure their better-coordinated functioning and interaction in an increasingly complex and interdependent social order; but rather is it essentially concerned with modifying and controlling the physical layout of city streets and their building improvements.

In a word, the city planner is, like the architect and the engineer, primarily a builder in concrete, stone, brick, and steel; only, instead of having his building project consist of a particular building, bridge, or highway, his structure is the city itself. Instead of using as units so many tons of structural materials, his units are buildings and open spaces and thoroughfares. In this sense he is truly a master builder, and his design has vastly more social implications than those involved in the construction of any one particular structure. Nevertheless he is basically a craftsman, a designer of material things, and at best only indirectly a social engineer in the sense applicable to a city manager, the executive of a big industrial corporation, the president of a university or of a nation, or the social scientist engaged in the formulation of better plans to diminish the present marked world-wide disequilibrium between industry's and agriculture's productive capacity and the larger public's ability to purchase and to consume.

However, let us note a major conclusion by way of introduction. Planning cities of the future, wherein full recognition is given to the welfare of the people who will live and work and visit within their borders, will increasingly become an enterprise involving the best judgment of a group of specialists in what heretofore have proved to be widely separated fields. As is already evidenced in some of the master plans, and more particularly in the New York Regional Plan, not only are the services of city planners, architects, and engineers required, but likewise those of the lawyer, the economist, the social worker, and the business man. Structural engineering and social engineering will and must become increasingly interdependent.

With due recognition of the social values implied in the amenities of living which are inherent in any ennobling civic design, let us focus our attention upon certain other aspects of the human factor which are not so evident, and yet which have a basic bearing upon the future of our cities and upon a social order dominated by the motif of city life.

THE URBAN URGE TO EXPAND

Every small town in America, and particularly every city, has aspirations of becoming bigger and bigger, and much of city planning has to do with the anticipation of an ever-expanding population and markets. Now the impulse to grow and to expand is by nature inherent in every organism, biologic and social, and as long as frontiers exist, group expansion, whether of colonies of plants or of animals or of societies of human beings, may proceed without undue interruption. But the passing of the frontier sets an unavoidable limitation upon this process, and expansion in one direction can only be at the expense of contraction in others.

As a comparatively young nation, and as a people whose major cities have rapidly grown up since the days of the Industrial Revolution and as products of its explosively expansive forces without being long rooted in and tempered by the older restraining cultures of a medieval and ancient world, we are prone to lose sight of the limitations imposed upon us by the passing of the frontier, and to continue to be worshipers of the god of size, as if mere size were the final touchstone of merit. When the author was abroad during the war years, he found that Europeans had come to expect Americans to brag principally of the size of their country, of its natural resources, of its industrial plants and products, of its population, of its social institutions, and of its civic structural achievements.

Unquestionably this striving to grow larger and larger as exhibited by all units of American life, to everlastingly increase the quantity of output in all lines, to increase the volume of capital invested in every enterprise and the number of its customers and patrons, regardless of the merits of competitors or the limitations of society's ability to expand and to absorb the products of expansion along all or along basic lines—this determination to grow bigger which seems to motivate every enterprise

[1] Assistant Professor of Sociology, University of Illinois.

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THE FIRST STAGE OF A REAL-ESTATE DEVELOPMENT NEAR CHICAGO

from the small-town retail store to the metropolis itself, is a basic factor contributing to our late overexpansion, inflation, and ultimate and inevitable economic debacle.

The grave limitations of our powers to expand regardlessly in any direction are already apparent. With one automobile in America for every five persons, the market for motor cars has already reached the saturation point, and the future output of automobiles, as far as the American market is concerned, must be essentially that to meet replacements only. In the light of this situation, Stuart Chase has suggested that a large proportion of the capital funds now being devoted to the automobile industry be diverted into wholesale slum clearance and housing projects, wherein lie the present greater social need and the greater opportunity to contribute to the welfare of the urban dweller. To be effective, this would call for a significant measure of economic and social planning and control, as well as more definite city planning along housing lines. It is, however, but one major instance of how city-planning projects are inextricably involved in the mesh of underlying forces operative throughout our larger industrialized society.

Or again, consider the inordinate growth of subdivisions of late years, in turn based on the assumed virtually unlimited growth of urban populations, together with the unlimited ability of those populations to invest in lots and their improvements. Having been for an appreciable period a resident subdivision manager of one of the larger and, it may be added, more meritorious subdivision developments in Cook County, Illinois, as well as the executive secretary of a real-estate board, the author writes with a certain definite appreciation of the problems facing the subdivider and the realtor's business or profession in general. Nevertheless it can hardly be denied that Cook County today is in large measure a monument to the follies of relatively unregulated, wholesale, premature, private speculative promotions of vacant-land development. The author was recently told on good authority that Niles Center, 12 miles from Chicago's City Hall, has enough business frontage laid out, and of course undeveloped, to care for half a million people. On the basis of the norm of 50 feet of business frontage for every 100 of expected population as recommended by the Chicago Regional Planning Association, the subdivisions that have already been made in Los Angeles County, California, have enough laid-out business frontage to provide for more than the entire population of the United States.

Real-estate enterprises, both planned and unplanned, have tended to ignore not only the limitations to the factor of population growth but likewise those affecting the ability of the population to consume. A study of the incomes of the population in the entire Los Angeles regional area in 1927 revealed that over one-half of the families had incomes of under $2500 and 92 per cent had incomes of under $5000. In New York City, the best available estimates give 69 per cent of all families with a family income of less than $2500. When it is borne in mind that the item of housing represents about one-fifth of the cost of living in all the great cities of the United States, there is little wonder that we are rapidly becoming a nation of cliff dwellers, if apartments and multiple residences may be so designated.

Edith Elmer Wood, in her late book "Recent Trends in American Housing,"[2] states the simple fact about American housing. "Two-thirds of the population," she says, "cannot pay a rental or purchase price high enough to produce a commercial profit on a new dwelling," that is, a dwelling which complies with the minimum standards of light, air, space, and sanitation. And yet Robert Whitten showed in a recent study that there are practically no houses of any sort being built in this country to sell under $4500. Moreover two-thirds of our American families have incomes of under $2000, and one-third incomes of less than $1200. No wonder, then, that in New York City about two million people are still crowded in old-law tenements which it has been illegal to build for thirty years.

[2] Edith Elmer Wood, "Recent Trends in American Housing," p. 46; The Macmillan Company, 1931.

Here again the grave disproportion between productive capacity and consumption ability fundamentally affects the welfare of the human element who must dwell in our cities. It is not the author's province to discuss specific remedies here. Fortunately they are being increasingly considered, and in a limited measure applied. The programs and funds of cooperative societies, limited-dividend companies, private philanthropists, and public and quasi-public authorities are bearing on this problem. Furthermore, it is becoming increasingly obvious that, thanks to the productive capacity inherent in our machine age, any lasting solution of the present depression must involve shorter working hours for the masses without a corresponding reduction in wages. This in itself will throw into even greater importance those aspects of the urban structural environment which are not specifically allocated to work and to business. With increasing leisure time, the urbanite's dwellings, as well as his recreational and educational opportunities, will automatically occupy more of the city planner's thought and attention.

CITIES CAN NO LONGER CONTINUE TO GROW INDEFINITELY

Professor Lohmann's emphasis on the growing need of planning beyond the urban border has a vital bearing on these fundamental problems. Our cities are due to decentralize; the suburban trend is already evident. The author had occasion to discuss the evidences of this more specifically in an article in last December's *Current History*.[3] But fundamentally, cities can no longer continue to grow indefinitely in size, our people can no longer, in the light of the present inadequate distribution of wealth and income, continue as increasingly potential consumers of the products of industry. The breakdown is already upon us. Our cities are caught in the vortex of the larger socio-economic forces which are rapidly reshaping society.

As a consequence, city planning in the future cannot continue to concern itself with the older competitively speculative, self-contained, and self-centered community of the immediate past, glorifying the mere size of its numbers and enterprises, and directing much of its talents and powers to enhance this attribute. The desire and efforts to render our cities more beautiful and more healthy have formed a complementary motif stressing quality as already recognized. But it is believed that most of us will agree that numbers, size, and tonnage have been central concepts, and that this concerted overemphasis has been and is now a basic factor in intensifying the social problems of our present-day urban world.

Since the social forces reshaping our cities are essentially outside of their own borders, city planning must emerge into regional planning, and both together must increasingly take into account state, national, and even international planning, at least in the fields now evidenced in the emergence of our international organizations. Social scientists already appreciate that basic problems touching our city life, such as policies in reference to tariffs and immigration, cannot ultimately be solved by nations acting apart. For the modern nation is no longer an isolated and self-contained unit, as no longer is the modern city, and the virtual disappearance of the world's frontier, together with the differential pressures of the population growths of different peoples in relation to the unequal distribution of natural resources throughout the globe, is forcing new international alignments and developing a new international consciousness.

[3] W. Russell Tylor, "The Exodus From Rural America," *Current History*, December, 1931, pp. 404–408.

TRENDS OF VITAL STATISTICS AS AFFECTING URBAN GROWTH

More definitely bearing on our size as a nation and on the potential growth of our cities is the due appreciation of the vital statistical trends of our population. Louis I. Dublin, statistician of the Metropolitan Life Insurance Company and a recognized authority in the field of population trends, estimates a maximum United States population—barring the factor of immigration—of 148,000,000, which will be reached about the year 1970. This is due to diminish, however, as the age distribution becomes altered, so that the end of the century will more nearly approximate a population figure of 140,000,000.

Ewing Galloway, N. Y.

A MODERN NEW YORK APARTMENT HOUSE BUILT TO REPLACE EAST-SIDE SLUMS, FINANCED BY THE AMALGAMATED BANK OF NEW YORK, AND SPONSORED BY THE AMALGAMATED CLOTHING WORKERS

Dublin's estimate for the year 1970 is about 20 million below the estimate for that year as predicted by Pearl and Reed's logistic curve for the United States. Nevertheless competent statisticians are in agreement as to the marked trend toward a stationary state of our population, i.e., a state in which births and deaths balance.

As one indication of this trend, it may be noted that although the total population of the United States increased 16.1 per cent between 1920 and 1930, there were 66,464 fewer infants under one year of age returned this last census as compared with the former one.

Moreover our large cities and urbanized areas are already incapable of growing by the excess of their own births over their own deaths, owing to the fall in the birth rate, which is a concomitant of urbanization. As a result they are increasingly dependent upon migrants from the rural areas for the source of their growth, and our rural South, in turn, is the only section of America which continues as yet to have a large enough excess of births over deaths to contribute to our urban growth.

As a striking evidence of this failure of large city communities to reproduce themselves, we may note that the three most highly urbanized states, Massachusetts, Connecticut, and New York—which are 92 per cent urban—in 1928 had 34,671 fewer white births than in 1920, in spite of their larger population. Studies of nine of our largest cities, as well as of ten of the most important German cities, and of London and Paris, indicate their inability to continue to grow from their own loins.

If we compare the growth of a city to the progress downstream made by a steamship equipped with sails as well, and liken the strength of the current to the migrations from outside to within its borders, and the set of the sails to a birth rate somewhat more favorable than it intrinsically is, because of the proportionately larger number of adults in the reproductive age groups in the urban than in the rural population, then it becomes apparent that a city's growth characteristically depends upon these essentially outward forces rather than upon its real genetic powers, which latter may be likened to the engine in the vessel. As a matter of fact, instead of contributing to such growth or progress, most of our large-city ships have their engines in reverse, and they would go backward instead of forward were it not for the forces from without represented by the favorable breeze and current.

As a specific illustration of this fundamental situation, observe that if the 1920 rate of natural increase of New York City—its own excess of births over deaths—had been the sole factor contributing to its growth since 1790, it would have produced by 1920 not quite 3½ per cent of the city's 1920 population.

With the cessation of immigration it is becoming evident that the replenishment of our urban populations is increasingly dependent upon the surplus population from our rural areas, and that as this in turn diminishes because of a falling rural birth rate, which is already the case, the future growth of our cities will be checked.

Although last year, owing to the depression, the net movement of migration for the first time in recent years was back to the farm—it is estimated that in 1931, 207,000 more persons left towns and cities for farms than moved off the farm—this is recognized as but a temporary trend. For one thing, modern scientific agriculture has made it possible for the agricultural needs of the nation to be fully met by something like 15 per cent of our population instead of the present 25 per cent who are now on the farms. The normal flow of population, therefore, is cityward, but the important thing to appreciate is that the volume of this flow should diminish in the future as our total population approaches a stationary state. We must not lose sight of the essential fact that, although our cities continue to show numerical gains, the rate of increase of our urban population is diminishing and will continue to diminish.

THE CHANGING AGE COMPOSITION OF OUR CITIES

Not only the quantity of the human factor, but certain aspects of its quality as exhibited in basic trends observable in the composition of our population, have in turn an important bearing upon city-planning policies.

Not only was there a decrease in the number of infants in the United States during this last census decade, but the 1930 census returned 128,840 fewer children under 5 years of age than did the 1920 census. Children under 5 comprised only 9.3 per cent of the total population in 1930 as compared with 10.9 per cent in 1920. Moreover the decline in the proportion of this age group was as marked in the rural as in the urban population.

In contrast with these losses are the noticeable gains at the other end of the age scale. Persons aged 45 to 64, inclusive, formed 17.4 per cent of the population in 1930 as compared with 16.1 per cent in 1920, while persons 65 years and over formed 5.4 per cent in 1930 as compared with 4.7 per cent in 1920. There were 1,700,590 more old people—persons over 65—in America in 1930 than in 1920. While the population under 5 years of age declined, that of all of the older age periods increased, and in general the older the age period, the greater was the rate of increase. Whereas the number of persons aged 5 to 9, inclusive, was 10.6 per cent larger in 1930 than in 1920, the number 75 and over increased 20.2 per cent.

A more refined analysis of the changing age composition in nine of our largest cities[4] is based on the stable age and sex composition that would result in their population if no migrations were to occur and if the actual specific birth and death rates of the population in 1920 were to remain in operation until the population were stabilized—in this case about 1975. In these nine metropolitan communities in 1920, 50 per cent of their white population were between 20 and 49 years of age. This, the most productive age period, both biologically and economically, would drop to 42 per cent of the stabilized population, or nearly one-fifth less of white productive adults. On the other hand, only 15 per cent of the white population in these centers in 1920 were 50 years of age and over, whereas the stabilized population would have 26 per cent or nearly double the proportion of old people.

[4] P. K. Whelpton, "Trends in Differentials of True Increase and Age Composition," *American Journal of Sociology*, May, 1930, pp. 876–878.

Based on the lower 1928 refined or true rate of natural increase, this stable population will be reached about 1950, and by 1975 the older ages will be still more heavily weighted. The period of stabilization advances as the birth rate continues to decline, and as the death rate rises correspondingly to meet it.

The actual and impending changes in the age composition of our population will have far-reaching social effects, and are in turn an important aspect of the human factor affecting the city-planning programs of the immediate future. The general social effects are readily discernible. With fewer children and more adults our vital statistics will be fundamentally altered. On the one hand, both marriages and divorces may be expected to increase. On the other hand, an overweighting in the proportion of the older age groups will mean that the crude birth rates should continue to fall and the crude death rates increase. This latter may be due not at all to any setback in medicine, public health, or accident prevention, but be simply the natural consequence of an older population. Already the expectation of life at age 40 has decreased half a year since 1920, although the expectation of life at birth today is higher than it has ever been.

In industry the factor of technological unemployment will tend to bear with increasing hazards upon the older workers, and intensify the problems of old-age pensions, support, and care. An ascending standard of living may be difficult to maintain. And so other social aspects in general might be alluded to. But in addition, these impending changes in the age groupings must have an important bearing on city planning.

With the continued fall in the proportion of children and the consequent lessened need of home playgrounds, there will be an increasing demand for small apartments and for family hotels which in turn simplify the work of housekeeping, with a corresponding decrease in the demand for single-family dwellings—quite apart from that due to inability to purchase them. Parks will have to provide more sunny benches and fewer swings and slides. Some school buildings may have to be converted into homes for the aged, although they will more likely be developed into civic forums and centers of adult education and recreation. The further decentralization of business and shopping centers may prove necessary, as increasing age on the part of the larger element of the population will make it more difficult for them to fight their way through congested centers.

Furthermore there will be a marked change in consumer demand, in turn reflected in the decentralization trend. Automobiles will be in proportionately less demand in so far as an older population should prove less active and mobile. This possibility should be reckoned with in the more elaborate plans for our street and highway improvements and development. Radios, however, should increase in importance, not only for recreation and entertainment but also as educational agencies; and these, together with the coming of television in the home, will tend to replace the demand for motion pictures and the drama, and thus considerably relieve the afternoon and evening congestion in our until now essentially centralized theatrical districts. Golf courses and country clubs beyond the urban border will increase in importance, as will also decentralized neighborhood centers.

Thus it should be evident that basic trends in the numbers, age composition, direction of movement, and purchasing power of our population—to mention but these major aspects of the human factor—and especially as these appertain to city populations, will have a vital bearing on the planning of the physical structures of these cities, as well as on the conditioning of their future activities.

CHANGES IN THE COMPOSITION OF OUR URBAN POPULATION

There are many other important aspects of the human element in city planning which time will not permit us to consider, although in conclusion we might briefly allude to some of them.

Not only is the composition of our population altering with its age structure, but it is being changed by our altered immigration policy. Fifty times as many immigrants were admitted to the United States in the year ending June 30, 1913, as in that ending June 30, 1931. What is to be the incidence of this change upon the ethnic cultural areas of our cities? Here again is a factor basic to the problems of our slum areas.

On the other hand, since the beginning of the Great War there has been a remarkable migration of southern Negroes—essentially a rural folk—from the farms to the cities of both the North and the South. In 1910 Chicago had 44,000 Negroes. By 1929 this number had increased to a quarter of a million. This movement of Negroes to the cities has increased the social pressure toward segregation and intensified the problems of urban racial adjustments. The housing, recreation, and transportation fields of life are more fundamentally affected than are the industrial by this movement. Specifically, shall we plan for more Negro parks and playgrounds and other centers, or provide for the more harmonious absorption of Negroes in existing agencies? Regardless of how we plan or the policies determining our planning, this increasingly important phase of the human factor in our cities will inevitably condition our planning.

Furthermore, planning the city involves more than planning for a specified number and character of inhabitants. One needs to know not only what type of city and of city improvements will be most desired and best appreciated by specified population groups, but also what the particular aspects of the urban material environment will do in molding the behavior of its dwellers. We have heard it stated that "mean streets make mean people." Jane Addams has embodied this thought in her classic, "The Spirit of Youth and the City Streets." More recently Shaw's studies of delinquency areas in Chicago[5] and in eighteen large American cities find them generally related to proximity to the central commercial area of the city, in so-called "zones of transition," which are under the impact of invasion by expanding business

[5] C. R. Shaw, "Delinquency Areas," Chicago University Press, 1929.

and industry, and are in turn characterized by physical deterioration and general slum conditions.

Dealing with the normal instead of the abnormal, one might pause and inquire what the city's sounds and glaring lights and more or less congested traffic are tending to do to the psycho-physical equipment and reactions of the urbanite. Are we to be deprived in significant measure of our auditory and visual responses and impeded in our powers of thought and concentration? If, as certain tests and studies indicate, such powers seem in a measure foredoomed as our urban civilization grows in intensity, then here is a big problem of a different sort for the city planning of the future, since it bears on the human factor.

One of our leading urban sociologists[6] has developed an interesting "shock-effect" theory in this connection, especially as it may bear upon the migrant into the city, who has not become thoroughly acclimated to the conditioning factors of urban life. It is his opinion that "many of the disorganizing effects of the city upon the individual (crime, mental breakdown, etc.) are to be interpreted not so much as effects of city life as such, but rather as the effects of the sudden impact of the characteristically urban set of conditioning influences upon a personality that has been accommodated to a characteristically non-urban set of influences. In short, certain individuals break down as a consequence of their failure to become adequately reconditioned to the city." Such a shock effect may be carried by imitation and tradition into the second or third generation of migrants.

If this is true, in conjunction with the importance of the migratory elements in the future growth of our cities, the need of diminishing the incidence of this shock effect in disorganizing personalities is all the more evident. But even if it prove to be an unverified theory the need certainly continues to exist that we make the physical environments of our cities such that they will tend not so much to detract from but rather to upbuild our physical and mental powers. For when all is said and done, the final touchstone of merit of an urban civilization lies in the strength of character and developed physical and mental powers of its people. The higher quality of the human factor is our ultimate goal, and our cities become truly great only in proportion as they serve this purpose.

[6] Niles Carpenter, "The Sociology of City Life," pp. 217–218; Longmans, Green and Company, 1931.

Courtesy City Housing Corp.

AIRPLANE VIEW OF THE WELL-KNOWN HOUSING DEVELOPMENT AT RADBURN, N. J.

Can New Construction RESTORE PROSPERITY?

By E. C. HARWOOD[1]

BACK in the days of the full dinner pail and a chicken in every pot, it was announced that a magic formula had been discovered which would perpetuate prosperity. Four years ago, in fact, Governor Brewster of Maine, in speaking before a conference of governors, is reported to have said: "It is the considered recommendation of the one who has received the overwhelming mandate of the American people to guide and guard their progress in the next four years that a construction reserve may prudently be accumulated in time of plenty against the lean year that is to come. This involves simply the provision of the necessary funds or credit to be released when indexes shall indicate the need, and such designation of projects as may commend itself to the authority concerned." In accordance with this hopeful announcement, administration and business leaders attempted, in 1930, to sweep back the tide of deflation with the broom of new construction. A great deal of money was unwisely spent, and the net result was that the depression was prolonged and made somewhat worse than it otherwise would have been. (This statement is not subject to statistical proof, perhaps, but it is worthy of note that events following the spring of 1930 have borne out predictions made by the author at that time.[2])

A RECENTLY PROPOSED MODIFICATION OF THE NEW CONSTRUCTION PROGRAM

Recently, a slightly different application of the new-construction theory has been propounded. This latest method of curing depressions would avoid the construction of any new industrial plant or any other so-called "capital goods." In place of new construction of that type, the building of roads, bridges, public parks, and the like is urged. Under no circumstances, it is said, should these facilities yield an income to the public treasury, nor should they compete with production facilities already in use. This proposal has been set forth in detail by David Cushman Coyle in a pamphlet entitled "Business Vs. Finance." Cleverly written, and offering a new solution of the problem, these ideas have attracted some attention and may yet receive the support of governmental bodies.

Now these various projects to restore prosperity or alleviate suffering among the unemployed have at least one feature in common, namely, that the taxpayer is to produce the wherewithal, sooner or later. Therefore it may be well to give serious consideration to this new-construction idea in order to determine, first, why the program inaugurated in 1930 had such unfortunate results; second, whether or not this latest variation of the basic idea is any sounder than the first; and third, what part, if any, new construction may legitimately play in the restoration of prosperity or the amelioration of the lot of the unemployed.

PREREQUISITE TO INTELLIGENT DISCUSSION OF THE SUBJECT AN UNDERSTANDING OF THE BUSINESS CYCLE

It seems more or less obvious that a prerequisite to intelligent discussion on this subject is a background of understanding of the business cycle. Granted that this knowledge is not to be obtained from every street-corner economist, it is nevertheless possible to sketch in the broad outlines of the processes involved. This can best be done with specific reference to the last period of inflation and subsequent collapse.

From 1924 to 1929 there was progressive inflation on an ever broadening scale. By the process of originating credit over and above that needed to distribute goods as they were produced, the banking system made possible an enlarged demand for many kinds of goods and services ranging all the way from new luxurious apartment hotels to the ordinary run of articles sought by the instalment buyer. This excess credit, originated on the basis of investment-type assets, enlarged the current money-income stream, which in turn supported prices of commodities when the normal post-war trend would have been sharply downward, and in addition made possible a vast speculation in securities which is still fresh in the minds of all. Of course, the process involved expansion in public and private debt, so that innumerable individuals and businesses were literally living on a margin. In the end, various financial disturbances abroad, together with a weakened banking system at home, precipitated a collapse in values which quickly pierced the margin line and forced continuous liquidation, and this, except for occasional intermissions, persisted for nearly three years.

At the peak of the inflationary period, the banks were overburdened with frozen assets. In other words, the banks, taken as a whole, had loaned far more on long-term security than the savings at their disposal ever justified. When the period of liquidation or deflation

[1] Assistant Professor, Massachusetts Institute of Technology, Cambridge, Mass.

[2] See "Criticism of Stimulated Construction as a Cure for Business Depression," *The Annalist*, May 30, 1930.

began, banks were simply forced to call loans and sell collateral in order to protect the interests of their depositors. But selling drove down values, and in turn forced more selling as thinning margins disappeared The vicious circle could only be broken by complete deflation of the inflated and unsound situation built up in the preceding years.[3]

It is important to realize that the process of deflation involves a drain on the flow of current money incomes which reduces them to such an extent that the remainder is insufficient to buy goods currently coming to market. This deficiency of purchasing power with respect to goods in the market necessarily persists as long as the deflationary process continues. Its effects are quite obvious in the long succession of price declines and reductions in output which mark the deflation phase of the business cycle. Deflation, then, which is the correction of an unsound situation, is the opposite of inflation in its effects on business conditions and the various markets of the world.

The foregoing is but an inadequate outline of a process which is exceedingly complex when all its related phenomena are taken into consideration. However, it will serve the purpose here. Keeping in mind this underlying explanation of the cause-and-effect relationships, we shall first attempt to discover the reasons for the failure of the forced-construction scheme in 1930.

WHY THE FORCED-CONSTRUCTION SCHEME FAILED IN 1930

In general, the original idea was that at the first signs of approaching economic difficulties, public and private agencies were to initiate vast programs of public works and private construction. If necessary, they were to borrow funds for such projects. Quoting Governor Brewster in his capacity as Mr. Hoover's spokesman again, "The release of three billions in construction contracts by public and quasi-public authorities would remedy or ameliorate the situation in the twinkling of an eye."

It will be remembered that late in 1929 and early in 1930, under Mr. Hoover's leadership, cities, counties, states, railroads, utilities, and even private businesses undertook new construction on a scale which at least approached the magic figure mentioned by Governor Brewster. At that time the deflation had begun. There was already a vast excess ($7,000,000,000, approximately) of long-term assets or investments by the banks over and above the savings of the country. The banks were greatly burdened with the difficult problem of retreating to a sound position. Yet at that time the new bond flotations for enormous new construction projects added to the unwieldy and impossible burden. That is to say, the scheme of saving the situation by initiating new construction projects involved making matters worse before they were allowed to become any better. Only a revival of the speculative spree would have made it possible to resume the inflation which ended in 1929, and if it had been resumed it could only have led to an even greater crash in the end. It is seen, therefore, that the scheme was inherently defective and extremely dangerous.

FALLACIES IN THE LATEST NEW-CONSTRUCTION PROPOSALS

The latest variation of the new-construction panacea offers a slightly different solution of the problem. This may be stated somewhat as follows: The initial difficulty and cause of the depression is that savings accrue at a faster rate than investments are made. Therefore there is a failure of purchasing power coming to market to balance the flow of goods. If these excess savings are invested in more plant equipment by various businesses, the result will only be to flood the market with more unsalable goods. Ergo, the thing to do is to pry these excess savings loose from the owners thereof by some kind of taxation, and embark on a vast program of public construction which must be of such character that it will not yield any income in the form of more goods. By so doing, purchasing power will be kept in circulation and the excess savings will not be allowed to become that business "poison" which the economist labels "capital goods."[4]

There are so many fallacies in logic and misunderstandings of the actual course of events involved in the foregoing scheme, that one hardly knows where to begin in demonstrating its futility. To begin with, there is no accumulation of excess savings during a boom. On the contrary, investments greatly exceed the savings of the public. This is no longer a matter of opinion. The incontrovertible facts have been compiled, and only one who disagrees with the principles of elementary arithmetic will care to question them.[5] In the second place, this scheme entirely overlooks the process of deflation which actually goes on during the depression phase of the business cycle. Liquidation of past excess-credit originations involves retirement of the purchasing power involved and a resultant drain on the flow of money incomes, as already pointed out. Consequently, diverting a portion of the remainder of the stream will not, by any stretch of the imagination, restore the balance between purchasing power coming to market and the value of goods produced—the condition that means normality.

Without going further into the details of this most recent application of the new-construction panacea, it is safe to assert that it also has its fatal weaknesses. It is based on a misunderstanding of the facts, and in addition is not logically sound. Therefore there are no grounds for hope that this variation of the scheme would be any more successful in restoring prosperity than were the original efforts of 1930.

On the showing made thus far, the new-construction path to prosperity seems to offer little promise of relief.

[3] This process, and the proof that the foregoing explanation is sound, will be found in the author's book, "Cause and Control of the Business Cycle," Financial Publishing Company.

[4] From the ideas suggested in "Business Vs. Finance," by David Cushman Coyle.

[5] See also the author's book referred to in footnote No. 3.

Does this mean that public projects can have no place either in restoring prosperity or in alleviating the sufferings of the unemployed? That is an important question. If it can be shown that public construction has a part to play which is economically and logically sound, those interested in the construction industry will accomplish far more, in the long run, by advocating such measures than they will by trying to persuade the public that new construction is the magic wand of the economic magician.

THE ONLY APPARENT JUSTIFICATION FOR NEW PUBLIC CONSTRUCTION IN A PERIOD OF DEPRESSION

In setting forth what is believed to be the only justification for new public construction in a period of depression, it is necessary to begin with one of the effects of the deflation process. This effect is unemployment. It is well known that manufacturers of all kinds, as well as other businesses and individuals, find it necessary during depression to reduce the numbers of their employees. At least they believe it to be necessary, and act according to that belief. Furthermore, the impact of technological changes is largely concentrated in periods of subnormal business.[6] In any event, the net result is that thousands of individuals are thrown out of work due to no fault of their own. For a large portion of them, finding employment elsewhere is impossible until business recovers to a substantial extent.

Back in the days when the unemployed could move on to a new frontier, there to find independence and security, the social problem was more easily solved. Even then tremendous hardships were involved, but it was possible for the unemployed to make a new beginning. Every man had the opportunity to secure his livelihood, and no society can long endure which fails to offer this opportunity to its members. It should be noted that this is *not* to say that society owes every man a living. A more vicious doctrine can hardly be imagined. But the social group, when it permits the private appropriation of a country's resources and unused lands, automatically incurs the responsibility for providing the opportunity to make a living. There is nothing radical about this proposition. It is only elementary common-sense based on the lessons of history.

EMERGENCY PUBLIC CONSTRUCTION MUST NOT OFFER MORE THAN A SUBSISTENCE WAGE

If it be granted, then, that it is a responsibility of the social group to provide the unemployed an *opportunity* to maintain life by their labor, it follows that public construction has a place in meeting depression problems. Obviously, work cannot be offered at prosperity wages to every man who wants it. The very evident need for economy in government makes this impossible. Furthermore such an offer by public agencies would result in a general rush to the government payrolls. On the other hand, if employment were offered by the various government bodies at a mere subsistence wage, the unemployed could be put to work without wrecking the public treasuries. Under such circumstances, actual cash payments to the unemployed might well be reduced to a minimum, pay being offered in actual food and clothing for the men concerned and their families.

With the wages on *emergency* public construction reduced to a minimum, many projects could be undertaken which would not otherwise be economically sound. The public would benefit by obtaining needed facilities at very low cost. Any semblance of a dole would thus be avoided. Of course, it would perhaps be advisable to limit the working time to a five-day week in order that the extra day might be devoted to seeking normal employment in the regular trade or factory work for which each individual happened to be fitted by experience or inclination. The fact that wages paid by public agencies on emergency projects were so very low would be a necessary incentive to the unemployed to find other work as quickly as possible.

It may seem a blow to labor's long struggle for an adequate wage to suggest that public agencies pay only the most niggardly wages on *emergency* construction projects. The contrast with present conditions, however, should convince labor that it will gain thereby. As the situation now stands, any one of the unemployed (with certain exceptions, of course) is only too glad to accept something even less than a decent subsistence wage in order to avoid starvation or the meager doles of charity. Employed labor is therefore confronted with competition of the fiercest kind, that of hungry men eager to fill their bellies. The result necessarily is that wages paid by industry at the lowest level need not even be sufficient to maintain a precarious existence.

If, on the other hand, the unemployed could be sure of a bare subsistence by working for public agencies, industry would be forced to bid somewhat higher for its lowest classification of unskilled workers, with beneficial results all along the line. Even private employers would have no legitimate objection to this scheme, because they would all be in the same competitive position. The employer's concern is not so much the precise wage which he is forced to pay as it is the relation of his labor costs to those of his competitors.

It should be emphasized that undertaking new construction projects in accordance with the principles above discussed will not serve as a magic formula to restore prosperity. The most that can be accomplished by this means is the provision of useful work for the unemployed. The limited funds needed for the work will have to come from the pockets of those who still have incomes. There will be no net increase in purchasing power on account of such undertakings. However, it will tide over the difficult time until natural forces have had an opportunity to restore normal conditions.

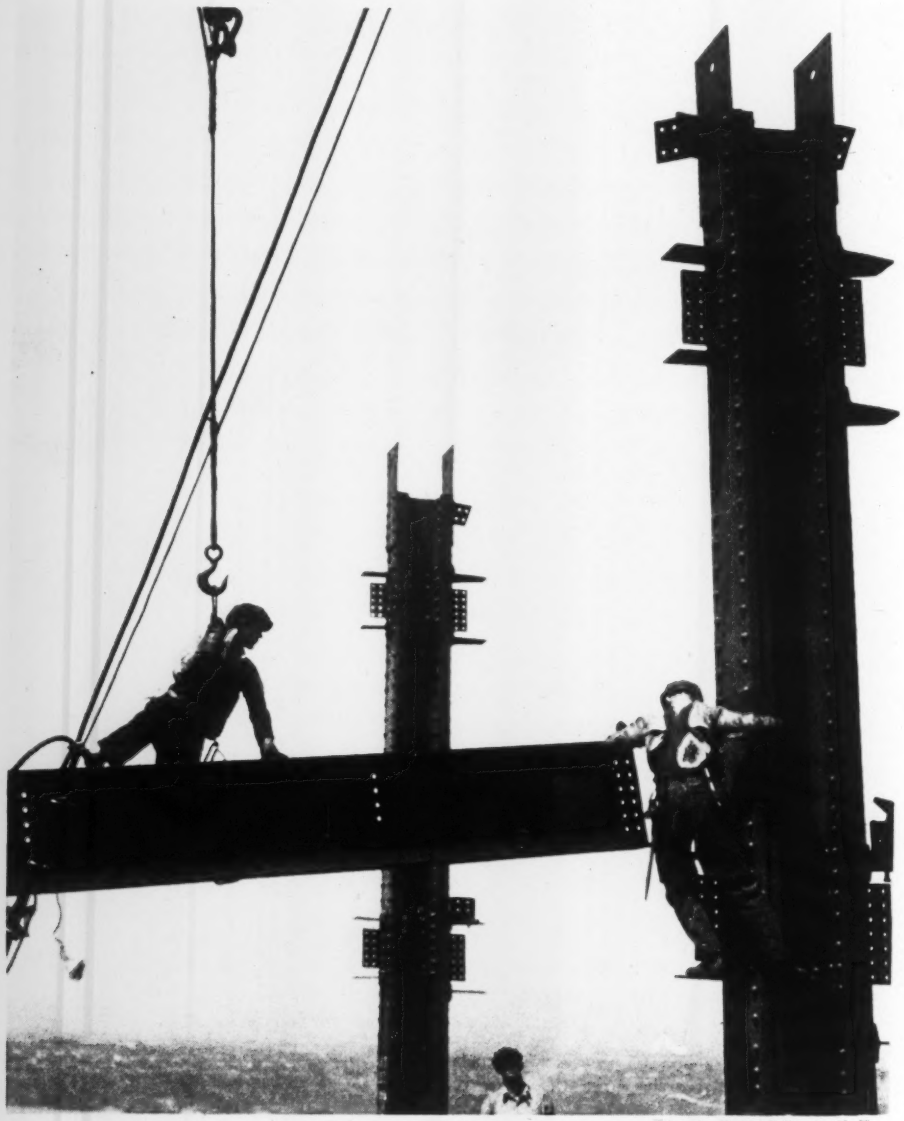
BUSINESS REVIVAL AWAITS COMPLETION OF DEFLATION

Within the limits of this discussion, it is not practical to deal in detail with the forces tending toward a restora-

[6] This is dealt with more in detail in "Cause and Effect of the Business Cycle," already referred to.

tion of normal business activity. It should be obvious, however, that an upturn in business is out of the question until deflation is completed; that is, until a sound position is restored. (Preliminary data indicate that such was the case in June, 1932.) When that has occurred, the drain on money incomes to liquidate past indebtedness ceases, so that goods coming to market find purchasing power functioning as effective demand in the market place. Manufacturers who manage to sell all of their products without further price reductions are encouraged to increase output. This means greater income for labor and the other factors of production. Gradually, all kinds of businesses build up to normal production schedules, because a mutual exchange of products is at last possible in the absence of deflationary drains on current incomes.

In conclusion, we may restate the principles which have become evident as a result of the foregoing study of the situation. First, extensive borrowings for new construction in order to avoid depression or restore prosperity are a hopeless and dangerous expedient; second, new construction, even when it avoids the creation of new plants and manufacturing facilities, cannot restore prosperity; third, new construction is a practical means of alleviating the unemployment situation, but the wages paid must be the least which will provide a bare living because of the terrific tax burden under which industry is forced to struggle in hard times. Our engineers are supposed to be practical men and presumably have a background of scientific education. They should find it possible, therefore, to grasp the importance of these ideas. If they will bend their energies to the advocacy of these sound principles, they will not only help the construction industry in which so many of them are vitally interested, but will also be doing their bit to assist their country in its hour of need.



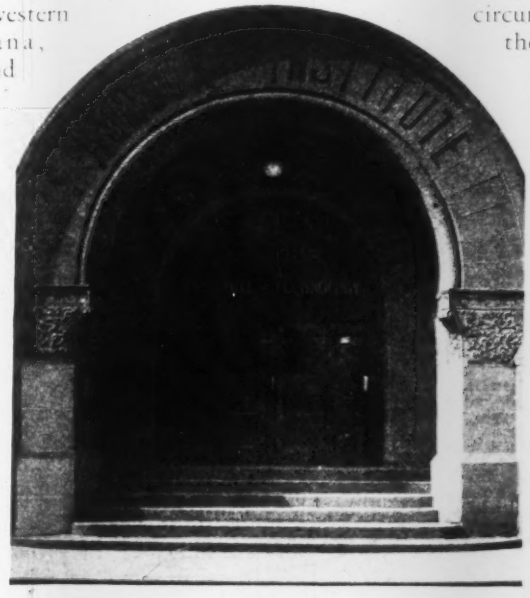
CONSTRUCTION WORK AT ROCKEFELLER CENTER, NEW YORK CITY —THE BRAINS OF MEN CONTROLLING THE BRAWN OF MACHINES

Photo by Ewing Galloway, N. Y.

The ARMOUR INSTITUTE DEVELOPMENT PLAN

Steps Taken in the Installation of a Plan That Recognizes the Joint Interests of the Institute, Its Graduates, Industry, and the Engineering Profession

By JAMES D. CUNNINGHAM[1]



THERE are, in the middle-western states of Illinois, Indiana, Michigan, Wisconsin, and Iowa, probably ten or twelve engineering colleges of excellent standing and good repute. In most cases a majority of the graduates of these colleges are absorbed by the industries of the Chicago area; that is, most of these young engineers come to occupy some technical or engineering position in an industry of the Chicago area. The fact that this absorption has not been taking place during the last two years, because the industries of the Chicago area are not hiring engineers from these or any other colleges, does not mitigate the fact that the graduates of these ten or twelve schools are still, in a sense, the "problem" of the industries of that area, in that these young men expect to find there an opportunity to put to use the training which they have received in college.

Armour Institute of Technology, in Chicago proper, is one of these schools. Founded in 1892, it has been turning out a large number of graduate engineers every year for forty years, and approximately eighty-five per cent of these graduates are filling some technological capacity in the Chicago industrial area.

Now it seems safe to assume that these Armour men have been, on the whole, neither particularly more nor particularly less successful in the practice of their engineering knowledge than have the graduates of any other well-established engineering school of the Middle West. Considering the entire group, one would undoubtedly discover that a few are very successful, some are failures, and a larger number have moved down the years with an indifferent success, affected rather by the circumstances of their lives than by the training which they received in college.

A few years ago the trustees and administrative officers of Armour Institute of Technology began to be conscious of some bad results which were attaching to this steady flow of more or less standardized engineers into industry. The fact that this dissatisfaction antedates the industrial cataclysms of the last two years, which have brought out those bad results in bold relief, is undoubtedly a healthy sign. The market collapse of 1929 and 1930, and the subsequent retrenchment of all production mechanisms, have at any rate enabled us to see quite clearly what might otherwise have taken years to discover.

The circumstances were these: The engineering colleges of the Middle West had been producing, year after year, a certain fixed number of engineers whom they sent out into the industrial world to earn a living wage. Now in each case the number of engineers produced was determined not by the demand, but by the equipment and facilities of the colleges, the amount of endowment at hand, or the funds which might be raised through appropriations. If a wealthy alumnus of some college wished to express in terms of limestone and steel his attachment to his Alma Mater, and if at the same time he or one in a similar position could make available a certain additional amount of yearly income from endowment, this college might forthwith increase its annual crop of graduate engineers by twenty-five, or fifty, or seventy-five, with little thought of whether or not there was a "market" for this larger output. The situation has its parallels in industry itself.

The inevitable result was that there were too many graduates who were labeled "engineers." Many of

[1] President, Republic Flow Meters Co., Chicago, Ill. Chairman, Board of Trustees, Armour Institute of Technology. Mem. A.S.M.E.

them were slipping, almost immediately after graduation, into secondary technical positions. It was unfair to the boy himself to give him expectations of normal engineering advancement. It was unspeakably wasteful to educate for engineering capacities so many who could never hope to become more than minor technicians. Ultimately, these conditions stimulated a new line of thought in educators at Armour Institute of Technology.

It is unnecessary to relate here the many discussions and exchanges of opinion which took place before a whole new concept of engineering education began to emerge from these fragmentary thoughts. It will suffice to explain briefly what that concept is, and to outline the development plan which has evolved from it, and which is guiding the educational policies of Armour Institute today.

THE TWO DEFINITE OBLIGATIONS OF AN ENGINEERING COLLEGE

The engineering college has two definite obligations: one to the student whom it graduates, the other to that whole scene of engineering and industrial activity into which the student is graduated. There is nothing new in this. Engineering colleges have always been more or less aware of this twofold obligation. But most engineering colleges have in the past tried to fulfil these obligations by methods devised, and from time to time corrected, largely within the educational group. Not only, as a matter of fact, in the number of engineers produced, but in the kind of education offered to whatever number of engineers were produced, the colleges have for the most part arranged their own schedules without any considerable regard for the actual needs of the industrial world. The result has been the wasteful confusion of engineers in technical positions which we see in industry today.

There have been reasons for this oversight, of course. The precipitous development of industry during the last two or three generations has left little time for careful analysis of its educational needs. In such rapid expansion there seems indeed to be "room for every one," and until a few years ago there has been ample room for most of the men the engineering colleges could produce. And the colleges themselves were stepping lively to keep abreast of scientific progress. The development of utilities, with its concurrent demand for chemical, electrical, and mechanical engineering services; the mushroom growth of the radio and aeronautics industries—these permitted no pause in which industry and the colleges might consult for the purpose of making sure that their respective procedures were in harmony.

Today we have that pause. The pace of scientific progress has not been slackened, but the translation of that progress into units of industrial production has very definitely been slackened, and in some respects, perhaps, it is well. It has given us at Armour Institute of Technology an opportunity to crystallize our new concept of engineering education, and to commence its application. It may be doing as much for many others.

And our idea, after all, is simple enough. It merely recognizes the obvious fact that there are three "vested interests" in the engineering educational process: the school, its graduates, and industry and the engineering profession. These groups are precisely comparable to the producer, the product, and the consumer of the product in a business enterprise. In the business enterprise the nature and quantity of the product are largely determined by consumer demand. Why should it be otherwise in education? The least we can do—and it is all that we are trying to do at Armour—is to establish permanent channels of expression through which the interests of each of these three groups may become and remain effective in shaping the educational process. This cannot but enable the college to dispatch its twofold obligation more efficiently.

Now it was felt at first that there might be some objection to the application of the idea on this basis: that it is all very well to talk of cooperation between producer and consumer, but when the producer is an educational institution and the consumer an engineer or industrialist, such cooperation is impractical. What, said a few of the skeptics, does the chief engineer of a transportation system know or care about curriculum or teaching method? And why, they said, do we have educational institutions and societies if not to work out just such problems as these?

A year's experience in the application of the Armour idea has revealed these questions as sophistries. The chief engineer, in most cases, knows a great deal about engineering curricula and teaching methods. In all cases he is keenly interested, willing and eager to assist. And the educator, in this case the administration of Armour Institute of Technology, has found that many of his problems are clarified in consultation with the consumer of his product. It may also prove to be just that external pressure to produce results which many feel is badly needed in most educational institutions today.

STUDY INSTITUTED BY ARMOUR TO DETERMINE THE PRESENT EDUCATIONAL NEEDS OF LOCAL INDUSTRIES

Let us review, for a moment, the action which this simple thought has stimulated at Armour in the course of a year. One year ago an investigating committee of the Board of Trustees went to work with three distinct objectives in view: first, to determine the present educational needs of the industries in the area served by Armour; second, to determine, by a study of the methods and practices employed at leading engineering colleges throughout the country, just how those needs of industry might best be fulfilled; and third, to establish, as has already been stated, "permanent channels of expression" through which this process of determining and fulfilling educational needs might always be carried on.

These studies have already been productive of salutary results. In the first place, we find that industry has several strenuous objections to the engineering graduate who has been sent methodically to the threshold of its employment departments each year. A composite of

these objections (voiced severally by the employers of engineers in one hundred representative Chicago industries) is about as follows: "This young man's vision has actually been limited by his education. He does not express himself well; he has a good knowledge of engineering subjects, but he is incapable of generalizing from that knowledge; and not only does he know little except engineering, but he also knows almost nothing of the economic and social significance of engineering!"

The vigor with which these criticisms were heaped upon the head of our young man makes even more amazing the fact that there have been no more general statements of these criticisms before. They have, however, produced action in the present situation. The administration committee at Armour Institute is now working out a rearrangement and liberalization of the various engineering curricula which places a far greater emphasis on such studies as English, history, language, economics, psychology, and sociology than has ever before obtained in the education of an engineer. This is being done at the sacrifice of many of the more specialized professional subjects in the undergraduate course. It may be significant to note that many of the latter are comparatively recent acquisitions. The need for specialization in engineering education has not been indicated in industry. There is, and always will be, a need for a very few men of highly specialized training. These men, who will occupy research positions in industry, must have a five-, or perhaps a six- or seven-year training, but this does not mean that the subjects which they study are universally useful and should be crammed into the undergraduate curriculum. "Give them the fundamentals of engineering and the humanities," says industry, "we can teach them technical details when and as they are needed!"

LIBERALIZATION OF CURRICULUM AN INITIAL STEP IN PLAN

Liberalization of the curriculum, then, is one of the immediate steps in the Armour development plan. There are other such internal adjustments which are being made in accordance with the findings of our first studies. One of these, a particularly interesting phase of the plan, merits some mention in this discussion. It will have been noted, perhaps, that the criticisms regarding the young engineer are such that they cannot all be wiped out merely by changing the curriculum. Behind all of these criticisms one can detect that age-old wail about all young people: "They are indifferent; they lack interest!"

Now there are several other ways in which we might seek to eliminate indifference and to stimulate genuine interests in our own young men. One is by a more rigid selection of students at the beginning of the college course, so that we shall have the very best of material to work with. We are raising entrance requirements. Another is by the most careful scrutiny of our teaching methods for the purpose of making sure that from each separate course the student will derive a maximum of effective knowledge and mental discipline. A committee of faculty members is making this examination.

There is a third method, however, by which this same result may be achieved. Experience at other schools has shown, and employment records in industry testify, that the student *who has paid for his own education* not only takes a more vigorous attitude toward his studies while he is in school, but also progresses more rapidly and more energetically after graduation.

The results of these particular studies are woven into the fabric of the Armour plan. A small student loan fund has already been started, and it will be augmented as rapidly as resources are made available. Moreover, the plan embraces a rigid program developing out of the loan-fund idea. The student body is to be gradually reduced, by the institution of more severe entrance requirements, and student tuitions are to be raised. This we shall try to work out so that the ratio between tuition and the per-student cost of plant and equipment operation will remain almost a constant. As this is done, a larger and larger amount will be made available for student loans, and students will be encouraged to take advantage of these resources. It is our aim to have ultimately a student loan fund in which every student is participating to some extent. The consumer of our product has told us that we can improve it in this way.

MECHANISMS PROVIDED TO INSURE CONTINUED COOPERATION WITH INDUSTRY

We need speak but briefly here of the mechanisms for continued cooperation with industry which are established in the Armour plan. As there is more general acceptance of the Armour idea on the part of other engineering schools, those mechanisms would have to be carefully worked out in the case of each individual institution. The location of Armour Institute in the center of a vast area of industrial activity makes it comparatively easy for close contact with industry to be maintained.

The Board of Trustees has been enlarged from ten to thirty-one members. The new trustees are broadly representative of the important commercial and industrial interests of the Chicago area; they constitute one part of the permanent "voice of the consumer" which has been incorporated in the educational scene. The nucleus of a larger Industrial Relations Committee has been formed. This committee will ultimately have about one hundred members, personnel managers and employers of engineers from a broad group of industries. These are the men who have already voiced their criticisms of the young engineer, and they assure the college that they are most interested in an opportunity to continue as they have started. The Committee on Educational Policy, a usual phenomenon in the American college, will work with the members of this committee to express those criticisms in college practice. Examples of their work have been recorded in this discussion.

Furthermore, a personnel and placement department has been established at Armour which is performing more than the usual employment functions of such de-

partments. In the first place, our close contact with industry is making it possible for the department to develop a system of personnel records which will be most useful to industry. This contact will also enable the department to keep a close check on the progress of each graduate after he is employed in industry, as a constant critique on the educational policies and methods employed in the school. This department is now in its first year of operation. The members of this year's freshman class, then, will be the first to have full four-year records under the new system, but it is hoped that the department can operate with some benefit to the present preceding classes.

These are the essentials of the Armour development plan, the operating realities which have grown out of the mere conviction that the separate groups which are interested in the educational process could cooperate to the advantage of all. They can, and they are doing so, and at no considerable expense to any one.

There are other elements in the plan, many of them of fundamental importance. The needs of industry indicate that a technical institute, to train men for the many positions in industry which require a specific mental or manual technical training, would be highly useful in this area. Armour Institute wishes to establish such an institution, entirely apart from the college in its operation, as soon as the proper resources are available. Similarly, the industries of this area could profit enormously by the services of such an institution as Mellon Institute of Industrial Research at the University of Pittsburgh. And Armour Institute wishes to participate also in the establishment of an institution making those services available.

But that is all in the future. So also is an extensive building program for Armour Institute of Technology. The present buildings and equipment of Armour are not adequate, and the development program will ultimately bring about a complete change of scene. Owing to the lack of funds, these things cannot be brought about until times greatly improve. And the administration and the trustees of Armour Institute of Technology are firmly convinced that the Armour development plan, in its essential elements as outlined in this discussion, will help, in time, to effect such an improvement. But the spirit of the Armour plan might be housed in shacks without greatly limiting its effectiveness.

CHEMICAL ENGINEERING LABORATORY AT ARMOUR INSTITUTE OF TECHNOLOGY

DEVELOPMENTS *and* TRENDS *in* MECHANICAL ENGINEERING[1]

A Brief Review of Science, Mechanical Technology, and Professional Development in 1932

EVER since 1925 the Professional Divisions of The American Society of Mechanical Engineers have prepared annual reports of progress in the branches of engineering in which they hold their major interests. These reports have been presented as reviews of the year's accomplishments and indications of trends that seem significant. They have been read at the annual meetings of the Society, and have been published in the Society's Transactions or in MECHANICAL ENGINEERING.

The reports for 1932 have been preprinted for presentation at the Annual Meeting, December 5 to 9, of the A.S.M.E. and will subsequently be published in the Society's Transactions. They have also provided a basis for the following review of the year's developments and trends which has been prepared for MECHANICAL ENGINEERING by the editorial staff. At the time this review was prepared, progress reports from the Hydraulic, Petroleum, Printing Industries, and Materials Handling Divisions were not available.

The following review of the year is divided into three major sections: (1) the science fundamental to engineering, (2) the technologies to which the A.S.M.E. Professional Divisions are devoted, and (3) more general developments affecting the engineer and his welfare. The technological section is based upon the progress reports of the A.S.M.E. Professional Divisions, to which acknowledgment is gratefully made. Material for the sections on science and professional development has been gathered from many sources.

I—Science, Pure and Applied

BACON divided all research work into two classes: *lucifera*, or that which produces enlightenment, and *fructifera*, or that which bears fruit. We refer to this division as one distinguishing between pure and applied science, the former presumably resulting in additions to knowledge, and the latter in gains in dollars and cents.

Of late this distinction has been becoming less and less definite, with the result that strictly utilitarian engineering has led to the development of scientific theories and facts, while the product of what would have been termed pure research only a few years ago has been eagerly grasped at by practical engineers and made to serve the needs of humanity.

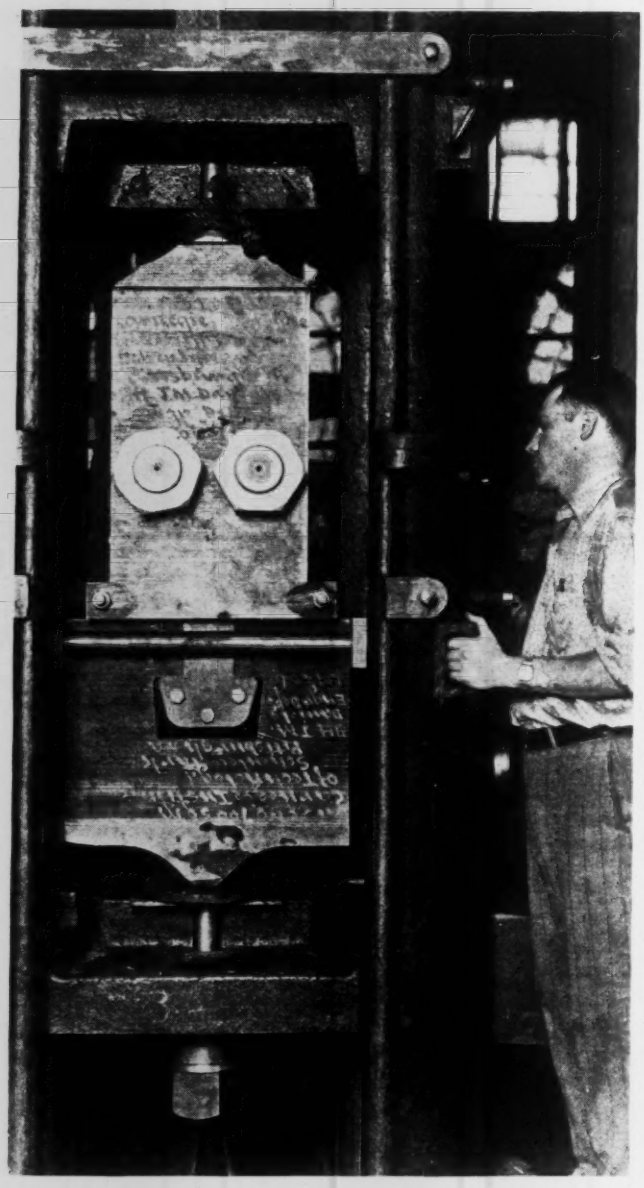
It therefore behooves even the average engineer to know clearly what the laboratories are doing in such fields as physical chemistry, quantum mechanics, and astrophysics. One of the most interesting branches of research in the past year has dealt with the structure of matter. Here the changes have been rapid and profound. Only a few years ago the structure of the atom was represented to us in the form of a heavy nucleus around which a number of electrons were flying like miniature planets around their central sun, the number of these electrons depending on and defining the character of the atom.

Of late, however, our confidence in this conception of the structure of the atom has been materially shaken. In the first place, it would appear that it is not the electrons or their number that define the characteristic properties of the atom. For example, if we take the iron atom and strip it of all of its electrons, it still will be essentially an iron atom. The nucleus apparently is not a mere lump of matter but a structure built according to a pattern of which we know absolutely nothing; we surmise, however, that the pattern is of such a nature that, given an opportunity, it will attract to it new electrons, and thereby reconstitute the iron atom.

Once we understand that such may be the case (and when discussing physics of the atom one should always use the humble "may be" rather than the arrogant "is" of the physics of yesteryear), it becomes fairly clear why we failed in our efforts to transmute metals by knocking out a few electrons. It was originally supposed, for example, that if we could knock out a single electron from an atom of mercury, we should obtain an atom of gold. It appears, however, that even if we do knock out an electron from an atom of mercury, we still have an atom of mercury, crippled it is true by the loss of that electron, but an atom of mercury nevertheless. To transmute elements we therefore have to perform the enormously greater task of shattering the nucleus, and of doing it in such a manner as to change its old mysterious pattern into one corresponding to that of the new element.

Much work is being done along this line at the present moment, particularly in England and Germany. In the latter country, it is understood, enormous funds and plant facilities have been placed at the disposal of the scientists engaged in this line of research. Similar work is going on in this country as well, but little about it has been published. It is known, however, that an attempt is to be made to shatter the nucleus by tremendous discharges of static electricity as well as by other means. If there is anything certain in modern physics, it is the likelihood that our present theories are either wrong or incomplete. We shall cite again the beautiful picture of a sun-like nucleus with planet-like electrons whirling about it at unbelievable speeds. Quite recently information has been obtained which, if found correct on recheck, would indicate that, in addition to the nucleus and the electrons, the atom contains something else, a kind of neutral body leaving, under proper conditions, a wabbly track on a photographic plate. What the nature of this neutral body or its functions may be, we do not know.

[1] Prepared by the editorial staff of MECHANICAL ENGINEERING from the 1932 Progress Reports of the A.S.M.E. Professional Divisions and other sources.



BREAKING TEST OF A LARGE-SIZE LAMINATED DOVETAIL OF T-SHAPED DESIGN

The subject of cosmic rays is receiving intensive consideration. More and more information is being obtained which tends to show that therein may lie the key to the ultimate control of life on earth, and that it is by preventing the penetration of the atmosphere by these cosmic rays that the presence of dust or smoke in the air becomes harmful to plant and animal life.

As to the nature of these rays, the Millikan theory seems to have been weakened by recent research. According to Millikan, these rays are the birth cry of matter recreated in distant space. The energy to generate them is accounted for in the following ingenious manner. We know that the atom of hydrogen has one electron, while that of helium has four. From an electronic point of view it therefore takes four atoms of hydrogen to create an atom of helium, assuming that the same proportion applies to the nuclei. On the other hand the atomic weight of hydrogen is supposed to be 1.008, and that of helium, 4.000. It would appear, therefore, that if four atoms of hydrogen are used in creating an atom of helium, four times 0.008 of something remains over, and it is this remainder converted into energy that constitutes the cosmic rays.

A body blow to this theory was given by the discovery that in addition to hydrogen of atomic weight 1.008, there can exist a hydrogen of atomic weight 2.000. If this is so, and there is little reason to doubt it, then the hydrogen that we know is merely a mixture of the hydrogen of atomic weight 1.000 and hydrogen of atomic weight 2.000, giving a hydrogen with an apparent atomic weight of 1.008. Such effects have been known elsewhere, and in themselves represent nothing unusual. If, however, hydrogen does exist in a form that has an atomic weight of 1.000, then four atoms of it can go into making one atom of helium without leaving anything over for generating cosmic rays.

In modern science luciferous research, or that which brings enlightenment, advances by sudden strides, answering one question at each and raising several.

APPLIED MECHANICS[2]

The theory of elasticity and stress analysis has made but little progress in the past year, except in the further study of comparatively minor matters. Among the advances of a somewhat major character may be mentioned the work of H. Reissner giving the general theory of stress distribution produced in elastic bodies by non-uniform heating or by some permanent set, and a paper by Föppl which presents a new method for solving two-dimensional problems in the theory of elasticity.

In the field of dynamics two outstanding papers were presented at the New Haven meeting of the A.S.M.E. The first comprises an elegant analytical solution by F. M. Lewis of the problem of the amplitude of a vibrating system which is accelerated or decelerated at a given rate through its critical speed. The other paper, by J. G. Baker, throws new light on the phenomenon of self-induced vibrations in engineering. It propounds the thesis that too much importance is usually attached to "resonance," because a large number of trouble cases are caused by "self-induction" rather than by "resonance."

In mechanics of materials the investigation of the properties of rubber calls for particular mention. H. Hencky has investigated the elastic behavior of vulcanized rubber in the course of his work in developing a theory of elastic behavior for materials admitting of large deformations. In the fatigue-testing field increased attention has been paid to elements of construction and stress-concentration effects. The strengthening effect in fatigue of cold rolling a surface has been further demonstrated. A method of testing models under the action of centrifugal force simulating the action of gravitational force on large structures and geological strata has been developed. Important work has been done in an effort to determine the causes of the cracking of concrete in large structures and this has resulted in the development of a new type of concrete that largely reverts to the analysis of compositions used years ago.

In hydrodynamics the problems of turbulence and of fluid resistances are still in the foreground of research work. Considerable effort has been expended in investigating the mechanisms of turbulence. Experiments are being continued regarding the effect of a temperature gradient perpendicular to the direction of flow with respect to the rate of turbulence.

[2] Condensed from the 1932 Progress Report of the A.S.M.E. Applied Mechanics Division.

By these investigations some light has been thrown on the complicated nature of the air movement within the atmosphere.

A new and very interesting experimental method for studying the internal movement of turbulent flow has been developed. By using the ultramicroscope, very interesting results have been obtained, particularly regarding details of the flow in the immediate neighborhood of a solid wall.

Another step forward has been taken in the theoretical treatment of frictional resistance due to turbulent flow. The theory of fluid resistance developed by L. Prandtl and Th. von Kármán has been checked by extensive tests on turbulent flow through smooth and rough pipes.

The time element as a factor in the development of cavitation has been studied. Considerable effort has been spent in investigating the influence of the compressibility of air in connection with the performance of thin airfoil sections having speeds near or beyond the acoustic velocity. This problem is of great importance due to the fact that the peripheral speed of a modern airplane propeller sometimes reaches, and even exceeds, the acoustic velocity.

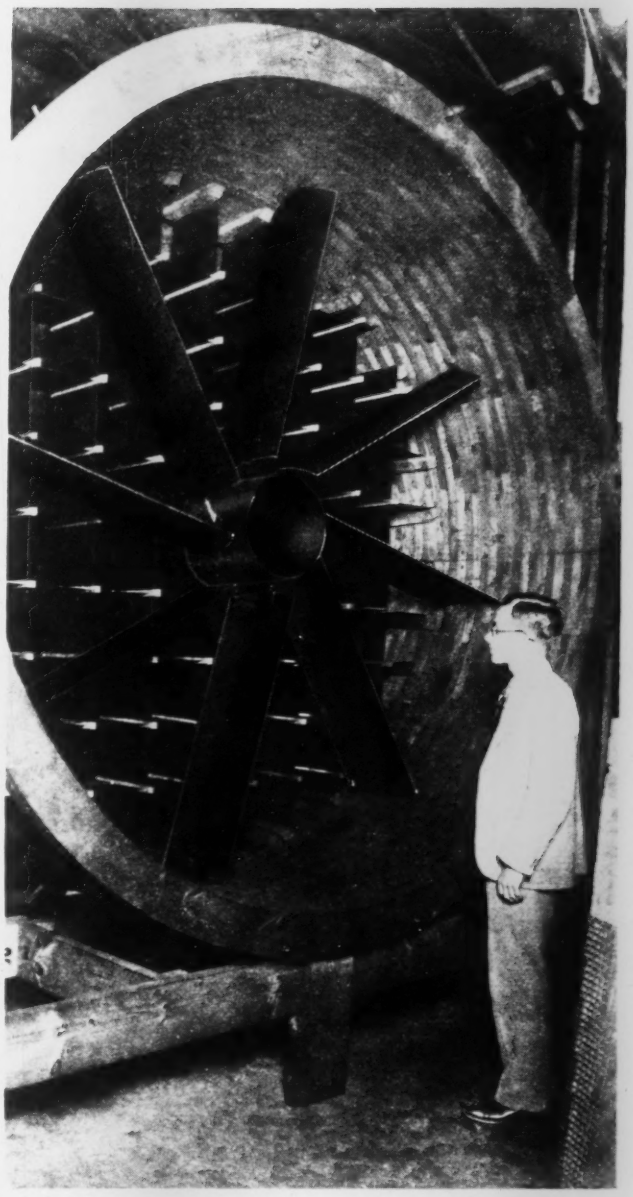
On the subject of lubrication, further work has been done in an attempt to verify the applicability of the hydrodynamic theory of lubrication to actual bearings. The effect of end sealing with pressure oil has been investigated experimentally, and the friction in bearings with concentric and eccentric shafts has been measured.

The analytical treatment of oil films was the subject of a paper by A. Kingsbury. Another paper presented a theory of the mechanism of lubrication based on the adsorption of oil films by the surfaces of metals. Much attention has been paid to proper methods of testing oils and to the lubricating qualities of oils. A number of oil-testing machines have been proposed. A method of evaluating lubricating quality by means of the wetting ability of an oil has been proposed before the Lubrication Committee of the Oil Power Division. Lubrication of rolling mill bearings has continued to attract attention. In connection with these bearings, attempts have been made to employ materials other than bronzes or lignum-vitae. Celoron and micarta have been suggested as heavy-duty bearing materials. Observations on water-lubricated rubber bearings have been published, showing a very low coefficient of friction.

In the field of thermodynamics of water and steam, of particular interest is the investigation by Koch into the behavior of water in the critical region, as his measurements of specific heat along the 240-atm isobar flatly contradict the contentions of Callendar that a discontinuity should exist to indicate a considerable value for the latent heat of vaporization at this pressure.

Hausen has attacked the problem of formulating the properties of steam in a new and very interesting manner. Starting with a quantum-theory calculation of C_{p0}, the specific heat for zero pressure, based on optical measurements of the so-called characteristic frequencies for the water molecule, he forms the difference $C_p - C_{p0}$ from available specific-heat data and finds an empirical equation which represents the variation of this difference with temperature and pressure. Applying well-known thermodynamic relations he derives equations for the volume and the enthalpy to within certain unknown pressure functions, which are then evaluated from the available experimental measurements of these quantities. The very satisfactory agreement of the resulting formulation with the experimental data marks it as a distinct contribution to steam research.

Keyes and Smith in their efforts to correlate various data on the properties of saturated water and steam and from a consideration of various gas-thermometry investigations, have been led to suggest a revision of the accepted value for the absolute temperature of the ice point. Preliminary calculations indicate a value of 273.16 C instead of 273.1 C. The work of the researches carried on under the supervision of the A.S.M.E. Research Committee on the Thermal Properties of Steam was reported in the February issue of MECHANICAL ENGINEERING.



INLET TO A WIND TUNNEL

Of immediate interest to the turbine engineer are the experiments of Burghauser, which indicate that friction at the walls of blade passages can account for only a very small proportion of the loss of efficiency actually measured. Keenan has called attention to a paper by Darrieus and, on the basis of it, has recommended certain changes in the customary method of judging the performance of the steam turbine. Keenan's paper, entitled "A Steam Chart for Second-Law Analysis," was published in the March, 1932, issue of MECHANICAL ENGINEERING.

II—Mechanical Technology

AERONAUTICS[3]

One of the most significant features of the past year has been a return to the development of unconventional ideas in the field of heavier-than-air craft. The success of the autogiro led to the development of two other types superficially employing the same idea, namely, Wilford's gyroplane in this country, and the Odier-Bessiere clinogyre in Europe.

It is understood that in England a type of rotor control has been worked out for the autogiro which consists of a control stick which is really a continuation of the rotor mast down into the cockpit. By rocking the stick from side to side or fore and aft, the masthead, to which the blades are hinged, also moves, producing lateral or longitudinal control.

BOEING XP-936 AIRPLANE

Both in England and in the United States cabin autogiros have been produced. The American machine, built by Pitcairn, is for four persons, and besides being a cabin type differs from the conventional 'giro in that the lower wing with upturned tips has been replaced by a highly tapered cantilever wing with a large dihedral. Two fins and two rudders are used.

The tailless "Pterodactyl" has provoked the development of at least two types of tailless machines in Germany. In the United States a considerable amount of work has been done in the development of a steam power plant for aircraft, while the Diesel engine for the same purpose may be safely said to have definitely arrived. Considerable progress has also been made in the past year in the direction of development of methods of blind flying, but the work on overcoming the danger of fog does not seem to have progressed as rapidly as was expected at one time.

Higher speeds have been made possible by a better understanding of fluid flow about bodies, and of the factors affecting the mutual interference and drag of airplane parts. It may be mentioned as significant in this connection that, notwithstanding the unquestionably great development of aerodynamics, there is still lacking a strictly tenable explanation as to why an airplane flies at all.

The subject of effective control of planes at low flying speeds has been investigated by the National Advisory Committee for Aeronautics, which developed some control devices in combination with rectangular and tapered wings, and wings with special forms of tip. Many devices for reducing landing speeds of planes with high cruising speeds have also been investigated. This has led to the design of a small fixed auxiliary airfoil head of the main wing. A very great amount of work has been expended on the problem of spin. The solution of the problem appears to lie merely in better control and stability at low speeds. The control of the voluntary spin (as differing from inadvertent spin) appears to lie in such design and arrangement of the tail surfaces as will give adequate yawing moments under all circumstances.

The matter of propeller development has been attracting great attention both from the point of view of employment of new materials and design of new types of controllable propellers, which includes propeller-testing apparatus. Facilities for stress research of airplane structures have been improved by the development of new equipment for measuring strains in such structures during static test. Also a new mechanical type of vibratory tensiometer and frequency meter has been designed to provide a means of measuring the rigging loads and the loads in flying and landing wires when a structure is statically loaded.

In the field of military aeronautics several new types that have been brought out have shown remarkable performance. One type of observation airplane is expected to give a high speed of 195 mph, while a general type has given a speed of 170 mph.

A problem of lubricating oil is the occurrence of decomposition resulting in the production of solid gummy deposits in the cylinder. Correction requires research into lubricating-oil properties. Studies undertaken along this line have resulted in drastic revisions in specifications, the new oils showing marked improvements in the condition of the engines after extended periods of research.

For the present, the Air Corps specifications for oil require a flat viscosity curve nearly equal to the best Pennsylvania characteristics and fairly low pour points, which necessitates rather severe, but not the severest, dewaxing. Decomposition characteristics are not specified, but are apparently fairly uniform as a result of control of viscosity-temperature curve characteristics. The Air Corps is entering upon a fairly large-scale test program of oil produced by aluminum chloride synthesis. Preliminary tests and investigation have shown very encouraging results.

In aerial photography extremely encouraging results have been procured with the new krypto-cyanine film which is used for the purpose of obtaining long-distance and high-altitude photographs. This is used in conjunction with the 89-A filter which excludes practically all visible light; thus the photographs are taken with infra-red light. This type of filter and film will be supplied to the service during the coming year. During experimental work with this film some very interesting pictures were taken. In January, 1932, Captain A. W. Stevens, Chief of the Aerial Photographic Unit, Wright Field, flying at 23,000 ft, obtained a picture of Mt. Shasta from a distance of 331.2 miles. This is the longest-range photograph ever obtained, and in one exposure covers the greatest amount of the earth's surface (7200 square miles)

[3] Condensed from the 1932 Progress Report of the A.S.M.E. Aeronautics Division.

ever encompassed. The negative was made from a point more than 100 miles farther south than the last point from which Mt. Shasta was visible with unaided vision. Captain Stevens also obtained the highest-altitude photograph of history in an exposure made at 39,150 ft, the view being that of territory lying in the vicinity of Rushville, Ind.

It is not without significance that so-called plumbing troubles, such as leaks from pipes and joints, especially in the fuel system, are still one of the major sources of trouble.

In aircraft-engine research perhaps the outstanding piece of applied research has been the study of the combustion process in the compression-ignition engine, with particular reference to the effect of fuel composition on the "delay period" and on the combustion rate. The work of Boerlage and Broeze in Holland and the photographic studies of combustion by the National Advisory Committee for Aeronautics, are considered particularly significant. This work should have important results in practical application, particularly with regard to control of fuel consumption to make possible increased engine output from high-speed compression-ignition engines, with perhaps eventual application to aeronautic work.

With regard to conventional engine types, the year 1932 has been marked by very significant increases in the ratio of power output to weight and to piston displacement, especially in the case of air-cooled radials. This was largely accomplished by the use of anti-detonating fuels, supercharging, and higher rotative speeds.

FUELS[1]

IN THE past year there has been intense discussion of remedial measures proposed for the regulation of coal production and marketing methods. None of the proposals appears to be likely to be adopted in the near future. The anthracite industry has made some progress, however, in holding its market and even enlarging it somewhat. The increase of automatic heating-furnace equipment has created a new demand for the smaller sizes of anthracite, and research is under way in an attempt to find uses for anthracite other than as fuel. Thus, for example, it is reported that anthracite fines have been found superior to sand in water-softening beds, and an investigation is now being made to determine the possibility of using anthracite as electrode carbon.

Strict enforcement of the proration laws in Oklahoma, and particularly in East Texas, has led to a reduction of oil production, with the result that producers are now obtaining a greater net return from a smaller volume of production. At a recent meeting it was frankly stated that the purpose of proration is not to conserve oil for future generations, but to control the supply for the market. The forward march of the employment of natural gas is still proceeding. It has modified the trends in boiler- and industrial-furnace design, and has affected the solid-fuel market to such an extent that the Interstate Commerce Commission has given the railways authority to meet the competition of Texas natural gas by reducing rates on industrial coal in the Middle West. The price of gas in the Far West is so low that water power has reversed its position, becoming a stand-by for steam generated by natural gas.

The realization that the economics of pipe-line transportation requires a high load factor has put natural gas in the position of usually carrying the base load. It has therefore been necessary to have available a substitute for it which has the same physical characteristics and which can be produced with high flexibility to carry the peaks. This demand has resulted in the development of a number of new processes. Foremost is the "Refractory-Screen Oil-Gas Process," which cracks low-grade oils on a refractory bed in a converted water-gas set. Deposited carbon is intermittently burned to supply the necessary heat. There are also two catalytic processes, one continuous, the other intermittent, which utilize butane for the same purpose.

A new way of removing hydrogen sulphide from natural gas is by scrubbing with a solution of salt and lime. This process is of especial interest since it has been shown that the addition of relatively small amounts of chemicals to oil-field water produces the equivalent composition of the salt-lime solution and permits elimination of the H_2S at a relatively low cost.

The situation in coal carbonization is unfavorably affected by lack of markets for the by-products, though some progress is being made in this direction. One example is the comparatively new fertilizer produced by mixing ammonia liquor with superphosphate fertilizer. A use has been discovered for ammonia thiocyanate, a recently developed by-product formed during the removal of cyanogen from gas. It has been found that the application of this material to soil results in immediate sterilization with the destruction of weed growth, but the subsequent decomposition of the material provides a latent fertilizer which prepares the soil for fresh vegetation.

Some interesting experiments are being carried out by the Detroit Edison Co. on the carbonization of coal by electricity. The principal appeal of such a process is that it would furnish an outlet for off-peak power. A public utility producing both electricity and gas might find the process profitable if it becomes technically successful.

An important development in pulverized-coal firing has been a modification in the design and operation of ball mills to eliminate lag, thus making it possible to handle sudden changes in boiler output when these mills are used with the unit-fired system, without an appreciable change in boiler pressure.

Several improvements in stoker design are noteworthy. Additional installations provided with zoned air control have been made, this system having demonstrated its usefulness and practicability under actual operating conditions. In one of the plants using zoned air control, it has been possible to operate at rates of firing up to 90 lb per sq ft per hr for long periods of time with air temperatures as high as 570 F.

A modification has been made in the design of multiple-retort stokers that permits continuous discharge of the ash without the use of a clinker grinder or crusher. This design is especially applicable where head room is limited, since it requires less space than either the dump grate or clinker grinder. The general trend in ash handling is toward a finer clinker, partly for ease of handling the ash hydraulically, and partly because of the greater use being made of ash for purposes other than fill. Clinker grinders to meet this requirement have been developed.

Improvements have been made in stoker-drive mechanisms, both mechanical and hydraulic, so that it is now possible to obtain almost an infinite variation of speeds within the limits practicable for stoker operation. Stoker sizes continue to increase. The average capacity of those ordered during 1932 was 330 hp, compared with the 1930 average of 276 hp.

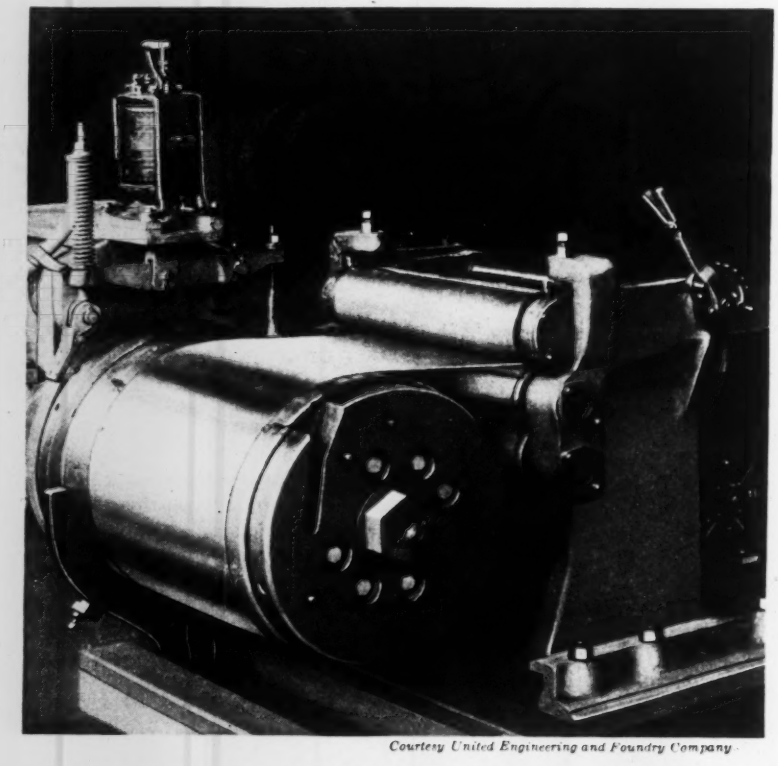
Figures on the sales of stoker- and pulverized-coal-fired units as reported to the Department of Commerce indicate a decided renewal of interest in the former. This may be due to the improvements in the design of stokers and a certain amount of disappointment with the operation of pulverized coal.

Still another reason for the increased popularity of stokers is the attention which is being focused on the elimination of stack discharge. Pulverized coal has certain advantages over

[1] Condensed from the 1932 Progress Report of the A.S.M.E. Fuels Division.

stokers, particularly for the combustion of coals having a high ash content or a low-fusing ash, and there is no danger that this method of firing will be displaced.

The most significant progress in industrial furnaces and kilns deals with the application of luminous flames for the dual purpose of increasing the rate of heat transfer and providing a non-oxidizing atmosphere. This development has been facilitated by the extension of natural-gas distribution and the availability of liquefied petroleum gases, both of which are well suited to this type of combustion. Luminous-flame burners are being used for various purposes already, and important research on luminous flames is under way. In the marine field great attention has been attracted to the use of colloidal fuel by the Cunard Line. This fuel consists of finely pulverized coal suspended in heavy oil in the ratio of forty parts coal to sixty parts oil. Apparently it is only in the marine field that such a fuel can be used, and only a comparatively small tonnage of coal is involved. Developments in gasoline production have progressed in the direction of better knock rating, increased volatility, and reduction of gum content, the better knock rating being obtained by increasing the percentage of cracked gasoline. A so-called safety fuel has been produced by the hydrogenation of petroleum, the same process being employed also for the production of lubricants. The most important Diesel-fuel development is the production of anti-knock oils. Surprising as it may seem, conditions which prevent knock in gasoline engines produce knock in the Diesel engine. The usual types of knock inhibitors are therefore harmful rather than beneficial in a Diesel fuel. Progress is being made in determining oil characteristics of importance to good operation, with special attention being paid to "ignitibility." There is still a need for satisfactory tests and specifications for Diesel fuels.



Courtesy United Engineering and Foundry Company

AUTOMATIC MACHINE THAT STRAIGHTENS AND COILS COLD-ROLLED STRIP AS RECEIVED FROM MILL

IRON AND STEEL[5]

The iron and steel industry has shown considerable progress in the past few years, largely in preparation for the expected severe competition that will come as soon as times improve.

An important development in the operation of blast furnaces has been that of so-called "slow blowing."

To the experienced blast-furnace operator the advantages to be derived from a careful adjustment of blast volume to the size and design of the furnace, and particularly to the quality of raw materials, have always been realized. The trend to large 1000-ton furnaces, as was pointed out six years ago, could scarcely have been justified on the basis of increased productivity alone. Careful observers at that time were fully aware of the fact that one of the chief virtues of the large units was their ability to turn out a required tonnage without being forced to take an amount of blast out of proportion to the volume capacity of the stack. There was always previously, however, a great pressure exerted upon operators to squeeze the maximum possible tonnage out of every existing unit. Recently, the pressure from the plant management has been to get as little tonnage as possible, while keeping the furnace in operation as a vital link in the chain of steel-plant manufacture, not only for making the requisite amount of hot molten metal, but as a producer of gas upon which the manufacture of coke and coke-oven gas, the generation of power, and the heating of metallurgical furnaces are largely dependent.

This situation has resulted in "slow-blowing," or blowing the furnace at a rate somewhere below the point of maximum production. Blast volumes were gradually reduced to keep pace with the operation of other departments. This was not done entirely without reluctance and opposition on the part of the furnace operators, for furnace men have been trained and tuned up to the policy of large production, which means heavy blowing. Many had anticipated serious operating difficulties from building up of hearth, bosh, and stack, with resultant hanging and checking, but these were not encountered. On the other hand, surprisingly good results followed. Flue-dust losses were substantially reduced, coke consumption was decreased, and the quality of the iron became more regular and better.

With the demand for tonnage declining over a period of almost three years, it naturally followed that the advantages derived from slow blowing should be pressed to the utmost, and today we have many instances of stacks being driven at only about one-half of what was formerly considered their normal rate.

Increased attention has been paid to the development of more economical and thorough methods of cleaning blast-furnace gas, and to its conservation by improving the efficiency of hot-blast stoves. In this connection, attention has been

[5] Condensed from the 1932 Progress Report of the A.S.M.E. Iron and Steel Division.

drawn to methods of wet electrical precipitation, partly because the basic patents on the precipitation principle have recently expired. In at least one type of electrical cleaner the final cleaning apparatus may be combined with the primary washer to form a single compact unit. For the conservation of gas and the attainment of higher blast temperatures, additional types of stove checkers designed for the purpose of more rapid and efficient exchange of heat between gases and blast have been introduced. Efforts have been made to accomplish increase of heating surface and heating capacity of existing stoves without removal of the old checkerwork. With this in view, spheroidal-shaped refractories have been designed for insertion in old checker flues when the areas are wastefully large for using thoroughly cleaned gas.

In open-hearth plants it has been found that newer plants with furnaces of very large size have usually been badly handicapped in producing the small tonnages ordered to special analysis. Small plants with 50-ton furnaces operating without hot metal have been able to show consistently the lowest ingot cost of any of the plants of this group during the last twenty months. This might not apply, however, to high percentage production.

One of the larger companies has been experimenting for a number of months with a method of firing the furnace through the roof, the flame being directed generally downward and toward the backwall. This experiment is being conducted with considerable secrecy, but it is understood that the time of heat is materially shortened with some fuels, and with a considerable metal saving as a result of using the method.

Another method involving the firing of the furnace from four points is being introduced, but it will probably be some time before definite results will be available for comment.

Notwithstanding the depression, several large mills have been built: for example, the wide-flange-beam mill at the Illinois Steel Co., and continuous-sheet strip mills at the Inland Steel and Otis Steel companies.

Strips have been rolled by this method to approximately 12 and 14 gage and up to 36 in. in width. The maximum rolling speed possible on the experimental mill is about 300 fpm, at which speed 4-in.-thick slabs 9 ft long are converted into strips of about 12 gage in 6 to 6½ min.

The experimental rollings have given good indications as to the commercial possibilities of this type of mill. Increased rolling speeds are possible that, if applied to an actual mill installation, would enable one stand to produce an estimated tonnage of approximately 12,000 tons per month of 36-in.-wide 12-gage strip. While no edging rolls are used on the experimental mill, they are contemplated in the design of any future mill in order to roll more exactly the desired width of product and assist in breaking up the initial furnace scale. The demonstrations have further indicated that a very satisfactory hot-rolled product is possible.

Further development in the modernization of hand-operated sheet and tin mills has continued during the year. Many hand mills have been equipped with automatic mechanical feeders and catchers in arrangements known as the "combination system" or "combination method." These have resulted in increasing the production of the old type of tin and sheet mills to approximately one and one-half and three times their respective original outputs, with savings in labor up to about $5 per ton, together with better quality of product, a higher percentage of prime material, lower scrap loss, and the elimination of hard manual labor.

Successful attempts have been made to enter the casing and similar pipe fields with electrically welded pipe in competition with seamless pipe.

MACHINE-SHOP PRACTICE[6]

The most significant progress in this field has been in the direction of application of welded structures.

While it is evident that welded structures cannot in every case replace castings with economic or engineering advantage, it is equally true that the use of these structures in the past has been hampered by lack of knowledge and some prejudice, and that with the availability of this knowledge, now resulting in a vastly increased usage, it may be safely said that during the next few years we shall see a steadily increasing number of products produced in this way, with advantages to all concerned in lightness, cheapness, strength, and efficiency.

Concurrent with this development there has also been considerable improvement in the technique of cutting metals by the oxyacetylene-torch process.

One fairly large machine-tool manufacturing concern in particular has systematically combed its designs and substituted welded structures for castings in a great number of instances. To the uninitiated the results have been surprising to a degree in strength, saving in weight, efficiency, and grace. This firm has had many of its welded products in use for a long period of time, and their stability and permanence of accuracy are as outstanding as the other merits referred to.

The evidence is not lacking that, despite the conservative attitude of some designing engineers, the day is not far distant when welded structures for major units will be standard practice.

There has been remarkable progress in the production of precision forging machinery. The Ford Motors Co. typing process of forging belongs to this class. In many cases work is now passed direct from the forging machine to the grinding machine without intermediate metal-removing operations.

Automatic loading devices have been provided on many individual machines or groups in an effort to reduce the idle or non-cutting time in the machine-tool cycle. The majority of applications of this kind have been made in connection with lathe and automatic turning machines. When it is realized that the average machine tool is actually cutting metal only during about 30 per cent of the total working hours, the importance of this development becomes apparent.

The outstanding technical advances made in lathe and automatic turning machines deal with increased power input, higher operating speeds, greater structural strength, and the addition of automatic controls and safety features. All of these have been brought about by the development and future prospects of the new cemented-carbide cutting tools.

In the screw-machine line one progressive manufacturer has announced the availability of a silent stock support which will prove of great assistance to screw-machine-parts manufacturers, due to the fact that the excessive noise that is now caused by the stock rolling in the iron tubes will be practically eliminated by this newly patented device.

Another improvement is a new nut-tapping attachment to be applied to screw machines, which makes use of the bent tap, and this attachment lends itself to exceedingly high production, especially for brass nuts. Other types of nuts can be taken care of by making special adaptations of the attachment.

Another item of equal importance is the 30-speed countershaft for screw machines, which makes the latter practical units for either steel or brass work, and avoids the necessity of having the machines arranged for the standard speeds or high speeds.

In the milling-machine field there has appeared a new type

[6] Condensed from the 1932 Progress Report of the Machine Shop Practice Division.

of horizontal boring, drilling, and milling machine, which can be arranged with a compound table. It reduces all non-cutting time, as well as duplication of controls at the front and rear of machines, and certain automatic features have been provided.

There has been a general increase in the range of spindle speeds. One concern in particular makes a practice of providing 32 spindle speeds ranging from 25 to 1800 rpm, and feeds from $\frac{1}{2}$ to 62 in. per min. This machine will aid in more efficient milling, as it adapts the machine to the latest cutting material, either tungsten or tantalum carbide, as well as to high-speed or carbon steel tools.

One Middle-Western concern has succeeded in developing an integral-key taper-shaft end. Shafts with such ends are produced by the hobbing method, using a special hob in a special machine which has been developed for this purpose. The advantage of this construction over the present S.A.E. standard taper shaft, using a loosely fitting key, is evident. This construction is particularly applicable to such places as the rear axles and drive shafts of automobiles, although it can be used wherever a severe reversible torsional action is likely to be experienced.

The new composition of cemented carbide for cutting steel permits increases in cutting speed as great as those that can be obtained with cemented tungsten carbide on cast iron and non-ferrous materials. Due to its new characteristics, among which is the elimination of practically all cratering action, or cupping out of the top surface of the tool, caused by the pressure and abrasion of the chip coming off the work, it is now possible to do many jobs formerly impossible with hard-carbide tools, such as light finishing cuts on soft steel, where the cratering action was so destructive. The chips seem to slide off the surface of the tool easier, there is less tearing action, and a much improved finish is left on the work.

This is an entirely new development in hard-metal composition, being a mixture of several carbides held together by a binder, and embodying a rare-metal carbide not previously used in this class of tools. It is manufactured by coating the cutting particles with a softer material which acts as a binder, mixing thoroughly to obtain a homogeneous and uniform mass, pressing together under enormous hydraulic pressure in a mold, and finally sintering at high temperature in an inert atmosphere in an electric furnace. This cementing process is similar to that employed in the manufacture of Widia cemented tungsten carbide, as developed by Krupp, and produces a remarkably uniform and homogeneous product, free from porosity.

Considerable progress has been made in the improvement of drop-forging hammers.

OIL AND GAS POWER[7]

In the field of oil and gas power the tendency toward larger and larger units continues. The qualifications of the Diesel engine for peak-load service are being increasingly recognized by the electric utilities, largely because of reduction of first cost ($85 per installed kw as compared with $150 only a couple of years ago). This decreased cost is due to engineering advance and such factors as the adoption of solid injection, the use of trunk pistons of progressively larger diameters, and the stepping up of the rotative speed.

Outstanding marine-engine installations of the year include the German gunnery ship *Bremse* equipped with 26,000 bhp in the form of eight engines operating at 600 rpm. The weight per bhp is said to be 14 lb, a truly remarkable figure. Development of the marine Diesel engine with a view to obtaining the most suitable types of engines for various services has been carried on intensively in Japan. While the United States has continued to lag behind the rest of the world in the development of large marine Diesel engines, it has made a creditable showing with small engines.

In regard to construction, the welded steel frame constitutes the most noteworthy innovation. It is welding that accounts for the extremely low weight of such engines as those of the *Bremse*. The hydrogen brazing of engine parts has also been introduced; instead of a casting, several simple forgings are made and united in a very effective manner by the new method. Important progress has been made in the adaptation of the Diesel engine to automotive uses. About 3500 of them are in operation in Germany alone. The General Omnibus Company in London is gradually replacing its gasoline engines by Diesels. In America at least four makes of trucks are now offered with Diesel-engine drive, and during the past year a goodly number of Diesel-equipped American tractors have been shipped to many parts of the world. The saving in fuel costs attainable with Diesel-engined vehicles is as high as 70 to 80 per cent, while, in spite of views expressed to the contrary, in acceleration and flexibility the Diesel truck excels the gasoline truck of equal power, as has been evidenced by Professor Langer's systematic tests and the favorable experiences of American operators with Cummins Diesel-equipped trucks, one of which holds a non-stop record of 13,500 miles (December, 1931). The majority of the automotive Diesel engines are around 80 hp, but now demand is being felt for more powerful engines. The top speed of 2000 rpm is today no longer exceptional, and the engine weights approximate those of gasoline engines.

Considerable progress has been also made in the adaptation of the Diesel engine to aircraft purposes. In America the Guiberson radial air-cooled Diesel has been flown, while abroad the Daimler-Benz Co. is said to be ready to announce the completion of a 750-hp aviation engine. Its observed fuel consumption is 0.366 lb per bhp-hr when developing around 518 hp, and 0.42 lb per bhp-hr at top speed. The German M.A.N. Co. has a 7-cylinder airship engine developing a peak output of 1200 hp with a total weight below 4.4 lb per bhp. In the railroad field the most interesting application of Diesels is that in the Budd Michelin 40-passenger rail car, which is equipped with a 90-hp Diesel engine of the Junkers opposed-piston type. Because of the use of pneumatic tires and welded-steel-sheet construction, the car weighs but 14,000 lb instead of 175,000 lb for rail coaches of similar size, and 90,000 lb for rail cars in branch-line operation.

POWER GENERATION[8]

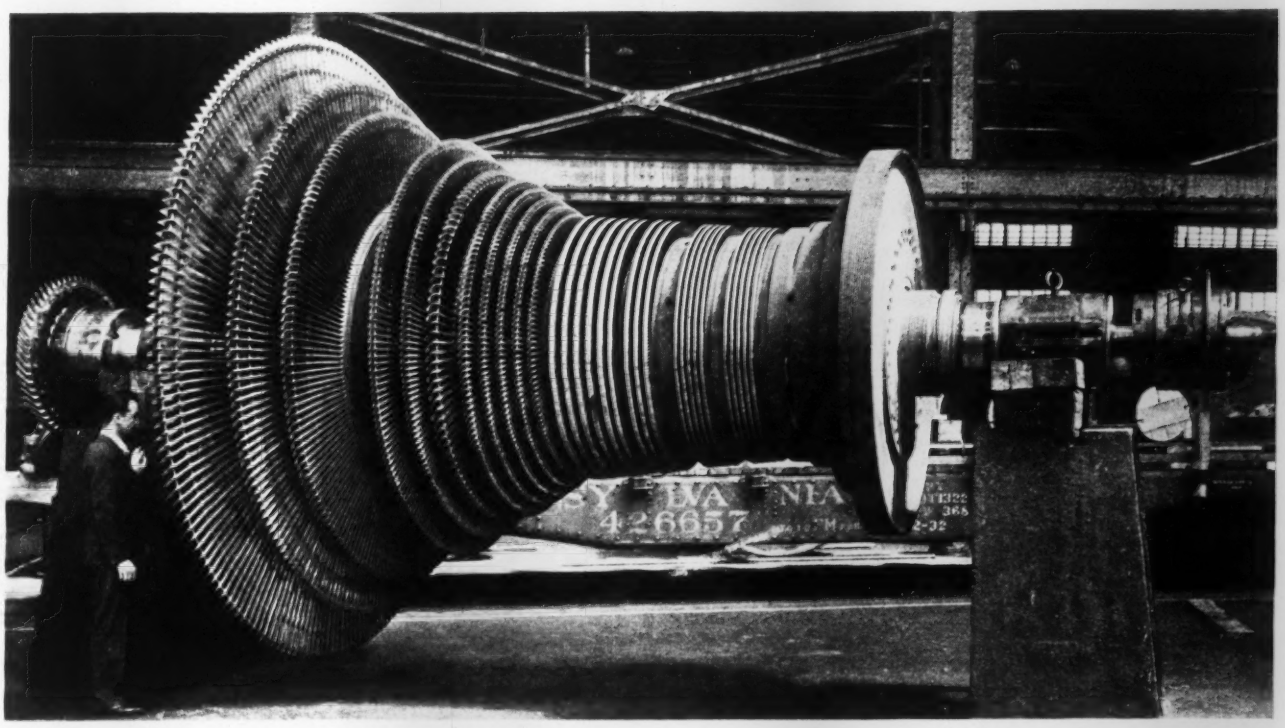
The past year has been an unusually successful one as regards developments in methods of power generation.

In general power-station design there has been a lay-off in the effort to increase steam pressure to the level of 1200 to 1400 lb with the necessary reheat, and the tendency is to use as high pressures as possible without reheat. Pressures of the order of 1000 lb and temperatures of 1000 F without reheat are in sight.

In the field of boiler design, fusion-welded drums have practically supplanted those of riveted construction. More attention is being given to means and devices to prevent the carry-over of solids with the steam from the boiler, and considerable work has been done to determine the mechanism of scale deposition in the boiler, and particularly the part played by carbon dioxide.

[7] Condensed from the 1932 Progress Report of the A.S.M.E. Oil and Gas Power Division.

[8] Condensed from the 1932 Progress Report of the A.S.M.E. Power Division.



A LARGE STEAM-TURBINE SPINDLE OF RECENT CONSTRUCTION

Steaming-type economizers are being increasingly employed because of the high temperature of the feedwater coming from regenerative feed-heating systems. The latest design of economizers consists of practically continuous welded loops.

Two radically new types of boilers, or rather steam generators, have appeared—one, built by Sulzer Bros. under the name of Velox; and the other, as yet in an experimental stage, of the rotary type. The Velox boiler is, broadly speaking, a steam generator with a pressure-charged combustion chamber, and may also be described as a gas turbine wherein the turbine proper generates only the power necessary to drive the compressor while the main heat goes into steam generation. The characteristic feature of the installation is that the combustion chamber is charged with an explosive mixture of gas and air, which is then ignited, raising the pressure in the chamber to about 4 to 5.5 times the charging pressure. The rotary boiler differs materially from the other rotary type previously known, namely, the Atmos boiler, in that the water acts as a piston and the purpose of its presence in the generator elements is to raise the steam pressure mechanically. The boiler elements consist of loops of tubing attached to a single shaft and rotating at speeds of the order of 2000 to 3000 rpm with the shaft. In their rotation the tubes pass through a special type of furnace which supplies heat, while water is supplied through passages in the shaft. Because of the rotation of the boiler elements the water is projected outward under the action of centrifugal force, and thereby increases the pressure of the steam.

A design has been proposed wherein steam at 120 atm will be supplied through rotary nozzles directly into a high-pressure turbine exhausting at 30 atm into a medium-pressure turbine.

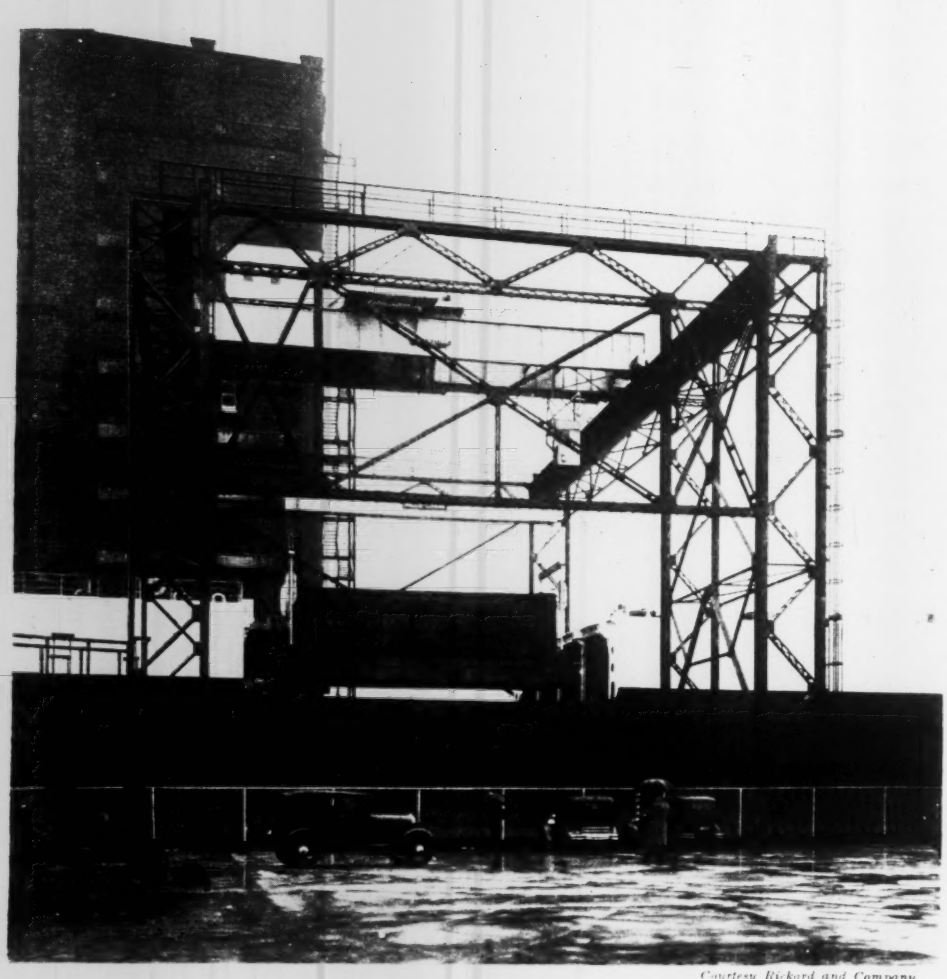
Abroad a good deal of attention has been paid to furnaces using blast-furnace gas as a fuel and equipped to use pulverized coal as an alternative fuel. A boiler plant involving certain novel features has been installed at the Trail Plant of the Consolidated Mining Co. in Canada, using gases generated in the course of recovery of zinc from lead-furnace slags.

In the field of turbines and generators the present tendency in large units is toward single-shaft machines. Research work on the design and materials of low-pressure blading has been carried on in an effort to minimize the wear due to moisture. Special steels, chromium plating, and stellite protection have been tried. At the present time stellite seems to offer the greatest promise.

Fabricated welded-steel construction is to a large extent replacing the use of castings. Welded-steel construction has not yet been used for the cylinders of large turbines. A number of small turbines have been built in this way, and its use for large units is receiving serious consideration.

Motor-operated turning gear to keep the machines slowly rotating when out of service for comparatively short periods are now almost invariably used on the larger units. The rotation serves to eliminate inequalities of temperature in the turbine rotor and thereby permit more rapid starting. On the larger units auxiliary high-pressure oil systems are being provided to float the rotating element before starting from rest, and thus avoid damage to the bearings.

Work is always going on on special cycles, exemplified in this country by the mercury-vapor cycle, and to some extent by the diphenyl cycle. In Europe increasing attention is being paid to mixed vapors. Diphenyl oxide has not been used commercially as a boiler fluid, but an installation has been made using it as a heat carrier to convey heat absorbed from the flue gases to an air preheater, thus eliminating a large amount of cumbersome and expensive duct work. Work on the Benson critical-pressure boiler is continuing, and one such installation has been made on the German steamship *Uckermark*. Incidentally, the Benson boiler is particularly well adapted for use in outdoor plants, which latter are attracting a good deal of attention at the present time.



Courtesy Rickard and Company

LOADING THE "SEATRAIN"

There have been several disastrous fires in high-pressure, high-temperature turbine plants due to leakage of lubricating oil. A particularly disastrous fire which destroyed the entire installation took place in Brussels, Belgium, although it has not been definitely established that lubricating oil was the cause of it. Earnest work, however, is being devoted to the problem of creating a fireproof lubricant.

RAILROAD MECHANICAL ENGINEERING[9]

The first two multi-pressure-boilered locomotives to be built for service on the American continent are the Canadian Pacific 2-10-4- and the New York Central 4-8-4-type wheel arrangements, both of the three-cylinder-compound design. The steam-generation and utilization principles made use of in these two locomotives have already been employed in three others in Europe with what are described as very satisfactory results in fuel saving and over-all efficiency, but the largest European unit of the type has only 42 per cent of the weight and develops only 36 per cent of the power of the Canadian Pacific multi-pressure one. These locomotives use steam at 850 lb per sq in pressure in the high-pressure cylinder, whereas the best of our conventional form of locomotives use steam at 275 lb, so there is over a threefold increase in steam pressure.

There has been an extension in the use of Lentz and Caprotti poppet valves fitted with both oscillating and rotary valve gear, and in the use of anti-friction bearings on locomotives.

The valve motion and rods present a peculiarly well-adapted field for roller-bearing applications, since the absence of wear in the latter guarantees that the valve setting will remain exactly as it was when the locomotive was turned out of the shop. As far as the rods are concerned, it is found that anti-friction bearings materially reduce the need for bearing attention, and there is no tendency toward that pounding which develops in the ordinary plain-bearing locomotive, and with the costly effects with which railway mechanical officers are thoroughly familiar.

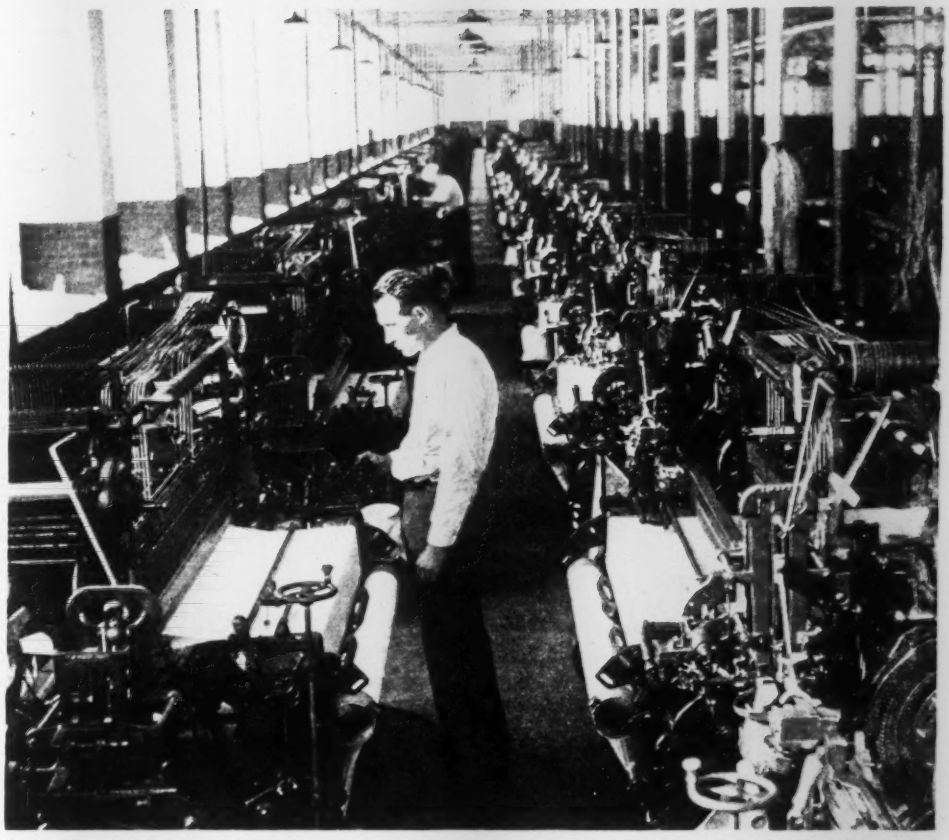
Increased attention has been paid to the use of new oils as a means of reducing locomotive maintenance expense, and during the year a number of Diesel-electric locomotives have been built with the cab, underframe, and trucks fabricated from structural-steel shapes and plates welded together. With the demand for increased coal and water capacities, the length of tender has been increased to an intolerable extent, to say nothing of the difficulty from the weaving and buckling of such tanks, causing leakage and cracking of the sheets. This has led to the introduction of the water-bottom tender which, in addition to permitting more coal and water storage, also provides a strong tender unit, combining the tank and frame with the solid corrosion-resistant bottom face of the frame, which in turn forms the lower member of a deep box-type girder. This construction permits a lower center of gravity and eliminates not only tank-bottom sheet maintenance, but, because of its greater rigidity, adds the necessary strength to the tank structure as a whole to permit economical maintenance. The steam-locomotive bed was first made with separate cylinders, which was followed with the cylinders being made integral with the locomotive frame.

The Pennsylvania Railroad has placed in service a new type of motor car for the Long Island Railroad. It is a double decker and will seat forty-four more persons than the old coaches. The suburban passenger car now in use has a capacity of 76, while the new type has a capacity of 120. The type is simple. It has two tiers of seats, one level above the other. The cars have a center aisle, as in the cars now used. On each side of this aisle seats are constructed facing forward, each roomy enough for two persons. The arrangement thus far is like that of railroad cars now in use. The departure from the customary arrangement lies in the fact that the seats are made in two levels. The floor board of the lower tier of

[9] Condensed from the 1932 Progress Report of the A.S.M.E. Railroad Division.

seats is 14 in. below the aisle, so that the seats are almost flush with the aisle floor. Passengers will descend one step to the lower-tier seats. The floor board of the upper-tier seats is above the central aisle. Passengers mount two steps to the higher seats. These are not directly above the lower seats, but staggered, one lower-tier pair of seats being succeeded by an upper-tier pair as the passenger walks down the car. The sunken seats in the lower tier permit the upper-tier seats to overhang, with still enough space for head room of passengers. Windows are so placed that each seat, upper and lower, has its window.

There has been considerable experimenting with air conditioning equipment. Oil-electric rail coaches have been built in Germany to operate at 93 mph so as to compete with air service. The cars are driven by engines directly coupled to a generator from which the current is supplied to two electric motors geared to the driving axle. The cars are equipped with two braking systems—one operated by oil and the other by air.



LOOMS AND LOOMS—A SILK MILL

To meet increasing competition, a number of railways are adopting means of coordinating railway and truck service, and are going so far as to move entire motor trucks and trailers loaded with merchandise by flat cars.

Another development which has attracted a good deal of attention is the "Seatrain," designed to transport loaded railroad freight cars in a triangular service between New York, Havana, and New Orleans. It is capable of carrying a load of 100 cars on four decks.

THE TEXTILE INDUSTRY[10]

Among the developments in this highly technical field may be mentioned the two-motor all-electric dye jig, as well as a number of machines and methods for shrinking cloth.

In the field of cotton manufacture a new jig has been designed to give a better penetration of the dyestuffs in the cotton finishing. What has been described as an entirely new machine for the twisting of wool, worsted, rayon, and cotton yarns has been announced, and a novelty twister for producing a wide range of fancy yarns has been introduced.

In process development attention may be called to the commercial production of cuprammonium rayon, and there is reported the possibility of the production of acetate yarn.

An electromagnetic shuttle-changing automatic silk loom adapted to fine rayon has been announced.

In the printing of cloth there is now available a multi-color warp-printing machine, so arranged that yarns in warp form can be printed in from one to four colors, and with which direct basic and acid colors may be handled.

Of the many new machines for the production of knit goods, mention may be made of a full-fashioned hosiery machine, which is what might be styled a jacquard machine that will produce an openwork pattern over the entire width of the stocking and is reported to produce this at an unusually high speed, namely, 70 to 75 courses per minute, depending on the gage of the yarn employed.

THE WOOD INDUSTRIES[11]

A new surface treatment has been developed for nails, by which their resistance to withdrawal is made from two or three times that of plain nails.

The past year has been marked by a more widespread use of forced recirculation of the air in large kilns by means of internal fans, i.e., fans placed inside the kiln. Experiments have been carried on with the introduction of forced circulation into the center of each truck load, with the motor-driven unit blowing into a plenum chamber. Such mechanical features as keeping the motor cold remain to be determined.

The search for chemical treatment to control the shrinkage and swelling of wood is proceeding. Several of these treatments have been found to possess high effectiveness, but labor under the disadvantage of making the wood attract moisture at high humidities. What is needed is either an effective chemical that is not excessively hygroscopic, or a satisfactory

[10] Condensed from the 1932 Progress Report of the A.S.M.E. Textile Division.

[11] Condensed from the 1932 Progress Report of the A.S.M.E. Wood Industries Division.

way of reducing the hygroscopic properties of the wood after treatment.

Considerable progress has been made in the United States toward the recognition of the value of the hot-press, dry-glue method of assembling plywood which has been successfully employed for some years in Europe.

It becomes more and more apparent that the old method of cold-press wet gluing was anything but logical, since it required the meticulous drying of all wood parts to approximately normal 5 per cent moisture content preparatory to applying the fluid glue that would carry this moisture content up to 15 per cent and sometimes 20 per cent during the pressing operation. The internal stress and strain introduced during the water-acquisition, wood-expansion step had to be later neutralized or eliminated as far as possible by a very careful redrying, which in turn might set up different internal stresses and strains.

Compared with this illogical process is the new and simpler way with its predrying of material to be glued to a known moisture content and its application of sheet or powdered glue. This results in a complete and final glue joint in the hot press, giving a sheen or luster to the face veneer, and requiring no subsequent redrying or attempts to neutralize interior stresses or strains. The product comes out much flatter, and the heat element permits a completely waterproof bond.

The glues used in this hot-press, dry-glue procedure may be of the phenolic resin type, which comes in sheet or powdered form, or animal glue, or a mixture of casein and latex. These latter two are prespread on the cross-band or other glue-receiving member, and predried before pressing.

A significant move has been initiated by the lumber interests, namely, a campaign for obtaining an annual crop of engineers trained to serve the woodworking industry. This is being done in collaboration with the faculties and deans of Purdue University, University of Michigan, Massachusetts Institute of Technology, and the University of Iowa.

III—Professional Development

THE impact of world-wide industrial depression has fallen with staggering severity on the engineering profession. Men who have been steadily employed throughout their entire careers, men whose services have been eagerly sought after in the competition of expanding industries, find themselves jobless or with income and practice drastically reduced. Engineering works that supplied opportunities for individual services and the output of mine, forest, and mill are abandoned through difficulties of financing them or because of programs of economy in public and quasi-public expenditure. The situation that developed with such rapidity during the past year faces little immediate improvement, and would be doubly discouraging to contemplate were it not for certain evidences of abatement in the deflationary process and a feeling of greater confidence in recovery. But the situation of the individual engineer, unemployed because of industrial stagnation, is still a grievous one, demanding the careful consideration and assistance of all who are competent and able to help.

THE UNEMPLOYMENT PROBLEM

Unemployment relief for engineers, organized and conducted by brother-engineers, has brought out some of the finer fraternal qualities that give character and solidarity to a profession. In some of the larger cities committees of engineers have gone about the business of looking after their own in a characteristically practical fashion. Faced with the fact that engineering jobs did not exist but that some manner of employment or relief was essential to the maintenance of morale, these voluntary organizations, representing engineering and professional societies, have raised money, canvassed their localities for jobs, organized made-work projects, non-competitive in nature but useful and worth while, provided relief where destitution threatened, assisted in meeting the problems of mortgage foreclosure and interest payments where the meager remnants of a life's savings were jeopardized, and supplied legal advice and protection where the need seemed urgent.

While in general these committees had their origin in great national bodies that were among the first to recognize the needs, they were essentially local and representative of many interests and organizations, and made their services available in most cases to non-members as well as to members of the local groups engaged in the relief work. It is probably safe to estimate, on the basis of known cases, that as many non members as members were aided. While it could not supply jobs where none existed, the Engineering Societies Employment Service, with increased appropriations from the societies that support it, has been giving valuable aid to members out of jobs and to the relief committees. Such evidences of the cooperative and generous spirit of the engineering profession toward its members and others in occupations dependent on engineering are extremely gratifying.

The unemployment problem is still a serious one and is likely to be so for several months. The problem of the re absorption of unemployed engineers should command the close attention of the profession for some time to come, and is likely to result in sober and constructive thinking on the requirements of the profession and the qualifications of its members. An interesting phase of this problem is that presented by the young graduate of an engineering college who finds himself emerging into a world where there are no jobs. There is also the serious effect on the morale of junior engineers who have either lost their jobs or who see opportunities for promotion fading into a distant future and accompanied by a keener competition at present levels. The disastrous working of these factors on faith and loyalties must be combated with courage and sound sense.

In this connection it is encouraging to note that the past year has seen the formulation, by seven major engineering bodies, of the Engineers' Council for Professional Development. Growing out of studies made by the A.S.M.E. Committee on the Economic Status of the Engineer, whose report on 1930 Earnings of Mechanical Engineers was a feature of the Annual Meeting in December, 1931, the increased interest in licensing and registration of engineers which the American Society of Civil Engineers has recognized in its development, with other bodies, of a model registration law, educational influences that have tackled the problem of the guidance of young men in their choices of a career, and the consciousness that graduate engineers need help and direction, as well as standards by which they may qualify for full participation in the rewards and obligations of the engineering profession, the Engineers' Council for Professional Development has before it worthy objectives and a comprehensive program. It is predicted that the formation of this Council will be one of the major events in the history of the engineering profession.

Interest in the licensing and registration of engineers has increased during the past year. In the May, 1932, issue of MECHANICAL ENGINEERING, Blake R. Van Leer presented a résumé of the present status of engineer registration laws and the action which numerous engineering societies took at the request of the American Engineering Council that the views of these bodies be on record. Results indicated a predominance of opinion in favor of registration.

Twenty-four of the 27 state boards of engineer examiners are members of the National Council of State Boards of Engineering Examiners. At the meeting of this organization in New York in September it was voted to join the Engineers' Council for Professional Development, to which five national engineering societies and the Society for the Promotion of Engineering Education also belong. Coordinated action of these societies in the work of the Council will give authority and direction to the trend toward registration and other matters affecting the profession and its relation to the public, the state, and educational institutions.

THE GROWING INTEREST OF ENGINEERS IN ECONOMICS

Arising also out of contemporary events has come a lively and inquiring interest on the part of engineers in economic problems, particularly those which are involved in such breakdowns of industrial life as we now witness. With characteristic vigor and confidence many engineers have invaded the field made famous by Adam Smith at the time James Watt was perfecting the crude steam engine of the 18th century. The general conviction seems to be held among a majority of engineers that, while complex and dependent upon the vagaries of human nature to a greater extent than are physical laws, economic principles are subject to analysis and formulation, economic problems can be solved, and a greater degree of control can be obtained. This faith, which is sometimes accompanied by expressed annoyance at the fact that economists and financiers have been unsuccessful in solving their problems as satisfactorily as the problems of the engineer have been solved, has led to much study and to many papers and reports on the subject. MECHANICAL ENGINEERING has published a number of such papers and reports, as well as many letters in which opinions and points of view on economic subjects are expressed.

Sincere interest in economic problems is a healthy state of mind for engineers, whose works, if they be worth while, must satisfy the requirements of economic principles. With engineering economy, i.e., the importance of the financial factor in design, construction, and operation, engineers have always been familiar. The term "dollar efficiency" has a real significance to them, and they reckon with it. The broader and more general aspects of economics, as they affect the national interest, and international trade and finance are less clearly understood, as, indeed, they are by others. It is gratifying to note, however, that engineers are honestly seeking the truth in these matters, and that they conduct their search, in general, with open minds and a profound sense of social justice. Judging from conversations, from many letters, and from papers by engineers, it seems typical of them that they are sympathetic to the interests of general welfare rather than that of classes. Probably this arises out of the managerial function that they most commonly perform, that requires a keen understanding of the traditional and individual points of view of those who own and those who labor. The necessity of effecting a harmonious and efficient organization demands that they give close attention to divergent points of view, and entitles them, in many cases, to a non-partizan status. The world is fortunate in having this growing class of intelligent men whose tact, tolerance, and sound judgment are effectively felt in social problems. The past year has drawn attention to the practical value of these qualities and to the importance, to society, of the engineers who possess them, for it has witnessed the greatest unemployment of modern times, requiring the laying off of men and the closing of factories, without serious social disturbances arising from the grievances of social differences. Not enough credit has been given to the practical social philosophy of these men who have made notable attempts to ameliorate the effects of unemployment and who, in consequence, command the respect of every one.

AID RENDERED BY ENGINEERS TO THE GOVERNMENT

Great national crises make demands upon services of specialists. During the World War the talents of engineers were laid at the disposal of the Government by engineers individually and by organizations representing them. Through the American Engineering Council, the engineering societies and organizations of the country have for many years been represented in Washington, where its advice has been sought in matters of legislation on which engineers might be presumed to possess expert knowledge and on the appointment of specialists to committees and commissions established for the national welfare. The past year has witnessed many such services rendered, particularly in the development of the Reconstruction Finance Corporation, to which an advisory board of engineers was added late in the summer. There should also be mentioned the work of the American Society of Civil Engineers in connection with a public-works program, urged as a means for combating the depression. The problem involved is one upon which many views are held and expressed. MECHANICAL ENGINEERING has published some of the representative views in the articles by David Cushman Coyle, in the September issue, by Harvey N. Davis, in the October issue, and by George L. Hoxie in the November issue. Elsewhere in this issue will be found another point of view expressed by Professor Harwood of M.I.T.

An outstanding contribution to the discussion of the economic and social problems inherent in the present crisis was the report of the American Engineering Council's committee on Balancing of the Forces of Consumption, Production, and Distribution. This report appeared in the June issue of MECHANICAL ENGINEERING and excited much comment. The Committee worked under the chairmanship of Ralph E. Flanders, whose penetrating analyses of present-day economic and social trends have been the subject of many papers and book reviews published in MECHANICAL ENGINEERING throughout the year. Nor would it be appropriate not to mention the excellent contributions in the way of opportunities for discussions of contemporary problems made by the Management Division of the A.S.M.E., and by other engineering and related organizations in meetings held during the past year. All over the country, it has been noted, groups of engineers have been meeting during the past year in informal discussions on economic subjects. Surely the result will be a clearer understanding of basic issues, and a better-informed public opinion upon which leaders in economic thinking can rely in presenting their programs for recovery.

DEVELOPMENTS IN ENGINEERING EDUCATION

And now let us turn from the events that have grown out of human misery and miscalculation to the abundant evidence of progress toward a better state of human well-being that is provided by developments in education. Not that contemporary and past events are not, as we have shown to the contrary, educative. Experience is a hard school, however, and lacks the orderliness by which more constructive gains are made. Out of the terrific impact of economic disaster on men and institutions will develop the antitoxins and the immunization by means of which our civilization will persist. The lessons will be analyzed and added to the textbooks. The world, and posterity, will gain thereby, and in the enlightening processes of formal education the truth will survive.

Engineering education in the United States is fortunate in

having an organization of teachers and interested persons working in its behalf under the name of the Society for the Promotion of Engineering Education. The numerous effective services that have been performed by this organization cannot be outlined in this review of one year's achievements. There has been, however, continued evidence of these services in the two summer schools for teachers of engineering students. These were the first that the society has conducted on the more general or liberal portions of the curriculum. The sessions conducted at the Stevens Institute of Technology were devoted to the teaching of economics, and the one at the Ohio State University to the teaching of English. Teachers of these subjects from all parts of the country took part in the two sessions, and the list of speakers was a particularly notable one. This emphasis on the non-technical portions of the curriculum is in line with the current tendency of a broadening conception of engineering as a profession and of the essential qualifications that engineers should possess.

Much attention has been directed to proper guidance in the early stages of choosing an engineering career. With the assistance of many engineering organizations the Engineering Foundation has prepared a helpful booklet entitled "Engineering, a Career—a Culture," which is to be placed into the hands of boys of secondary-school age, their parents, and their teachers and educational advisers. There was also held for the second time a summer camp for boys of this age under the auspices of the Stevens Institute of Technology. The Institute, under the leadership of Dr. Harvey N. Davis, is making a substantial contribution to engineering education in these guidance camps. The principle involved seems sound and helpful, and there is no reason why the camp idea should not spread. Studies of the aptitudes and mental characteristics of the youths at these camps are providing immediate benefits to the boys and their families, and are also resulting in the accumulation of much case material for educational psychologists.

Passing momentarily to the subject of adult education, it should be noted here that, again under the leadership of Dr. Davis, the Stevens Engineering Camp was once more used for a conference of engineering graduates of numerous colleges on the subjects of money and banking.

On the work of the engineering colleges themselves, little detailed comment can be made because of lack of space. Of particular interest to mechanical engineers was the inauguration, in several groups of its student branches, of the new grade of A.S.M.E. student membership. Closer contact with the Society is aimed at in this change, which will eventually go into effect throughout the country.

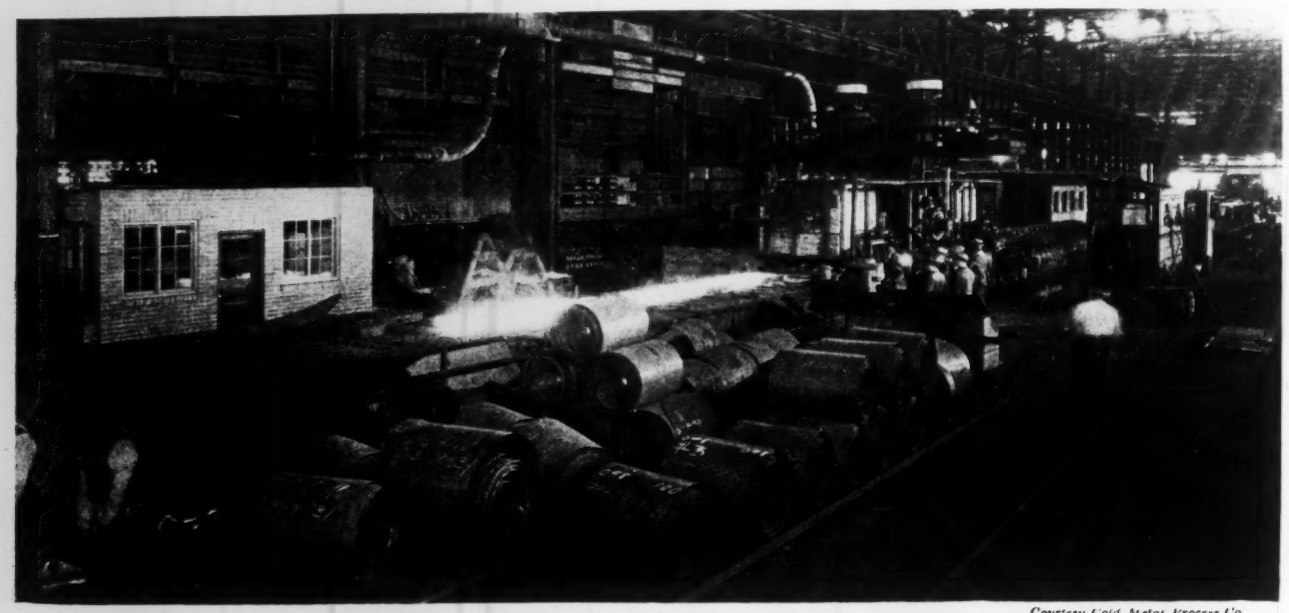
Most of the factors that have just been noted come within the scope of the tasks which the previously mentioned Engineers' Council for Professional Development is prepared to consider. They relate to the continuing contacts from secondary school, through college and apprenticeship, to full membership in the profession, with all that this implies in the way of guidance, education, certification, and registration.

A notable contribution to the philosophy of engineering education was made by Dean R. E. Doherty, of the Yale School of Engineering, Yale University, in an address at the Cleveland convention of the American Institute of Electrical Engineers, and published in the July, 1932, issue of *Electrical Engineering*, under the title "Educational Aspects of Engineering and Management."

A tendency, particularly attributable to the times, for enrolment in graduate courses to increase was noted at the Corvallis Meeting of the S.P.E.E. when a report on this subject was presented. At this same meeting Dean Dexter S. Kimball read a paper[12] on "Modern Trends in Engineering," which is recommended to those who are interested in a vigorous presentation of the point of view of an educationist. It has been noted that enrolment of graduate students in engineering increased from 1000 to 3000 between the years 1925 and 1931, and that numerous joint programs of part-time graduate study have been set up between some of the larger industrial organizations and engineering schools in their vicinity.

Enrolment in undergraduate courses seems to be holding up, although official figures are not available. A trend toward greater enrolment in urban institutions can be explained by hard times, as young men find it less expensive to attend the colleges in their home cities.

[12] See *The Journal of Engineering Education*, October, 1932, p. 77.



Courtesy Cold Metal Process Co.

STECKEL HOT MILL AT BRIER HILL

A Chance for
ENGINEERING PROGRESS

IT HAS BEEN repeatedly stated that one of the main reasons why the Germans were able to make such tremendous progress in research before the War, was the availability of low-salaried but very high-grade scientific personnel. A research worker was not expensive to employ in Germany in those days. At the universities bright young men vigorously competed for the right to become a privat-docent, that is, an instructor or lecturer receiving no salary and but nominal fees, at times no more than $10 a year. In the technical laboratories there were hundreds of men with the degrees of Doctor of Philosophy, Doctor of Science, etc., who had done from one to three years of post-graduate work and were receiving salaries which union laborers here would have rejected with contempt. The economics of this phenomenon went deep into the structure of German life. So valuable socially was the mere title of doctor considered, and particularly a connection with a university or technical or medical school, that parents were willing to provide for years an allowance to their sons, and there were always young women whose families were glad to endow prospective husbands for them for the sake of possibilities in the future and the halo of social light in the present.

Because the time of research workers did not cost much, German laboratories were enabled to perform the millions of experiments that led to the development of their marvelous chemistry of synthetic materials—dyes, medicines, explosives. Until comparatively recently, however, the situation has been entirely different in this country. True, the large engineering and chemical companies made every effort to attract graduates of good schools into their service and then turn them over to their research and development departments. But although during the one or two years that these young men studied with the companies they were paid little more than a living wage, the cost of research was many times greater than in Germany, and as regards the employment of real research workers, they were obtainable in the past only at respectable salaries. All this made the cost of research in this country comparatively high and produced a tendency to concentrate on major problems where the returns in case of success would be substantial enough to warrant the hazard on the cost of a given venture.

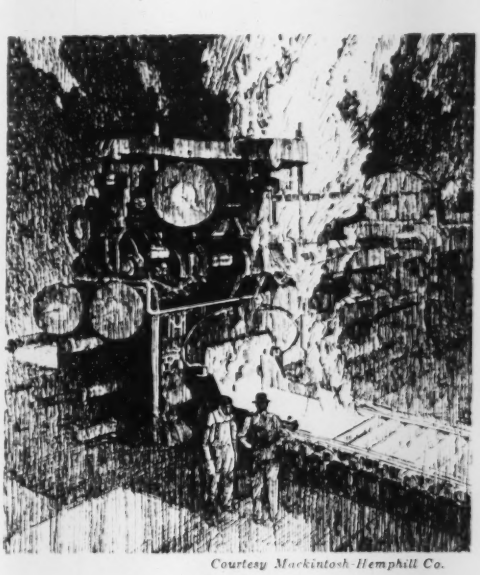
Now, however, we are passing through a period when a large number of men capable of conducting research of the highest grade in the fields of engineering, chemistry, and science are available, sometimes at ridiculously low figures, and it would seem that manufacturing companies could make no better investment than in engaging the services of these men and in initiating programs of research and development which, if done a few years from now, will cost many times as much. The intense competition not only between manufacturers in the same line but between industries requires that every large producer shall not only be up to date but at least two or three years ahead of the procession if he does not want to wake up some fine morning, only to find that unexpectedly he is several years behind. Moreover, so rapidly do changes take place and so closely interwoven are the various branches of science and engineering becoming, that merely a thorough knowledge of his own industry may prove entirely inadequate to a manufacturer.

Thousands of instances could be cited in illustration of what has been stated above. Within a few days an announcement has been made of an automatic engraving machine, in which a picture is scanned by means of a photoelectric cell and the engraving mechanically reproduced through the instrumentality of current control. The construction of a radio tube led to the development of a new branch of medicine. The invention of a process for making cheap phthalic acid created a new condensation material, while the production of the super-hard carbides of metals used in cutting tools is revolutionizing the machine-tool industry.

It was stated years ago that a railroad consists of the good-will of the public and two lines of steel, which latter would become two lines of rust without that good-will. Andrew Carnegie said that if all of his mills were suddenly destroyed by fire or earthquake, he would have them back again in a year, but if his men were lost to him, the whole business would be gone. It is no exaggeration to state that the modern manufacturing company, no matter how large it is, consists of the brains of its employees and its patent rights, while the plants, which look so impressive on the balance sheets, are becoming little more than secondary tools of manufacturing. Where would any of our billion-dollar oil companies be today if they did not have the right to use the cracking process and modern improvements in pipe lines? Where would our electric companies be if not for their patent rights, and chemical companies if not for their accumulation of research knowledge?

It is not unnatural, then, to wonder why the manufacturing companies in a position today to acquire brains at bargain rates are so slow to do so. Now, if ever, is the time for them to act, building up organizations of trained and inquiring intellects that will become the sources of our industrial progress in the future. Every such organization built up to perform useful research becomes the potential source of new industries, capable, without doubt, of supplying work for thousands of willing workers, and of increasing the wealth of the world and the well-being of civilized society. Without such industrial reconnaissance the battle for economic survival is likely to be stupidly waged, and perhaps lost through ignorance of the proper means of adaptation to changing conditions.

LEON CAMMEN



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MECHANICAL ENGINEERING

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GEORGE A. STETSON, *Editor*

The American Society of Civil Engineers Is 80 Years Old

IN the October issue of *Civil Engineering*, Mr. George T. Seabury, secretary of The American Society of Civil Engineers, writes on the outstanding events that have marked the development of that great engineering society that celebrates its 80th birthday this year. Heartiest congratulations on this anniversary spring from the lively sense of appreciation that all engineers have of the achievements and prestige of this society.

The American Society of Civil Engineers has the distinction of being the oldest of the major engineering professional societies in the United States. It is the progenitor, in idea if not in fact, of the numerous other organizations that have followed it. When it was founded, civil engineering connoted a broader field than it does today, the term being generally applied as a means of distinguishing works that were of a non-military nature from those which were primarily related to the art of warfare.

With the growth of an industrial civilization, and of invention, lines of major interest among men of engineering pursuits diverged greatly, and a centrifugal process developed from which there came about the organization of other groups of engineers such as the A.I.M.E., the A.S.M.E., the A.I.E.E., etc. The scattering of interests, with strict attention to the problems that were most closely related to the groups that formed these societies, was a perfectly logical and necessary phase in professional development. Important groups, small in numbers at the start and subject to submergence with older and more general interests, were able, with the individuality and autonomy derived by separate organization, to develop the technologies in which they practiced. That common interests have since drawn these societies closer and closer together, as is evidenced by their common habitation of the Engineering Societies Building, the pooling of their libraries, and their participation in numerous joint endeavors, is also a natural and logical development that in no way detracts from the prestige of the participants or destroys the advantages of distinctly individual organizations. The truth that dawns when contemplating the honorable record of the 80-year-old American Society of Civil Engineers and its younger associates is that maturity provides the wisdom and experience by which common action on matters of common interest can be intelligently and efficiently undertaken.

Quality and Volume

QUALITY and volume of business are essentially incompatible, as modern industry has been finding out within the last few years. One of the main causes for the trouble of motor-vehicle-tire manufacturing companies has been the rise in the quality of their product. Where formerly a tire was only grudgingly guaranteed for 5000 miles and seldom made over 3000, today it is not unusual to find a set of tires which has run from 15,000 to 25,000 miles and is still in serviceable condition. Of course, a large share of this improvement is due not to the tire itself, but to the availability of splendid, smooth roads over which the car travels. Nevertheless, taking road and tire together, the demand for the latter has been reduced at least one-third by the longer life it now has.

In the field of steel engineering, we are beginning to find the same situation. The use of better steels and, in particular, better corrosion protection are already eating into steel tonnage, and show every indication of continuing to do so on a still bigger scale.

The replacement of guesswork by testing is also leading to the same result. In times gone by the railroads replaced sections of their track for fear of rupture of a rail in service. Today they run a test car over the track and find which rails are bad. Only the defective ones are replaced, and this is resulting in a material reduction of expenditure by the roads' maintenance divisions and a corresponding reduction in the tonnage of replacement rails that the steel companies get.

Similar instances could be cited almost without number. What is the way out of it all is a difficult question to answer. Fifteen years ago an automobile was good for, say, 25,000 miles of average service, and then required replacement or extensive overhaul. Today no company would dare put out a car that would not travel twice that many miles, and the higher-priced cars are at their best after they have run some 10,000 to 15,000 miles. Obviously, this situation cannot be helped by deliberately lowering the quality of products, for the sales departments of competing companies would see to it that this fact became known to prospective customers. Improvement in quality will from now on continue automatically, and cannot be stopped even if it seems desirable to do so, which, of course, it does not. But, obviously, if an elevator rope can be used a year longer because of the possibility of testing it instead of scrapping it, irrespective of quality, at predetermined intervals, less rope will be required, unless more and more buildings are erected.

The only two conclusions that seem to be obvious are (1) that we have to think as strenuously about finding new markets for our products as of improving the products themselves; and (2) that competition in quality is becoming so strenuous that only the producers of the best goods at the most reasonable prices can survive. This, in turn, means that research and development departments instead of being, as is the case not infrequently today, mere appendages to manufacturing plants, will become their main guarantee of progress.

To Users of Cutting Tools

FREDERICK WINSLOW TAYLOR delivered his epoch-making paper "On the Art of Cutting Metals" before The American Society of Mechanical Engineers, and thus showed the practical manner in which the engineering method of analysis can be applied to problems in which the variables are so numerous and unfamiliar as to make empirical solutions almost mandatory. Associated with him, and working in the same field since that time, have been numerous investigators who have provided a wealth of published and unpublished material which, if properly coordinated, should be of immense practical value to users of cutting tools. Such a coordination is contemplated by a Subcommittee on Metal-Cutting Data of the A.S.M.E. Special Research Committee on the Cutting of Metals, in the form of a proposed series of handbooks as announced in the October 22 issue of the *A.S.M.E. News*.

Users of metal-cutting tools particularly are urged to express their comments on the proposed series of handbooks for the benefit and guidance of the committee, and to cooperate in offering to the committee such unpublished data as might be helpful to it. Communications addressed to King Hathaway, chairman of the subcommittee, will be most gratefully received.

A Century of Railroads

THE *American Rail-Road Journal*, which was established in January, 1832, and, under numerous names and publishers (from 1887 to 1896 the publisher was M. N. Forney, one of the organizers of The American Society of Mechanical Engineers) passed through a century of railroad progress, appearing today as the *Railway Mechanical Engineer*, was, to all intents and purposes, the first so-called trade or business paper published in this country. It therefore initiated an important development in periodical literature, and retains to this day a usefulness and authority in its field that does credit to this venerable tradition. The passing of the century mark in American trade-paper publication is appropriately commemorated in the October, 1932, issue of the *Railway Mechanical Engineer*.

Following the illuminating historical review of the magazine and the industry it has served, one is conscious of the importance and significance of the railroad in the development of the United States and in the advance of civilization. Those scoffers who tried to convince the original publisher and editor, D. Kimball Minor, of the futility of his plan to provide a paper for an infant industry that boasted but 200 miles of track in operation, have been thoroughly discredited, as most scoffers at progress eventually are. Perhaps they are not to be blamed for failing to share Mr. Minor's enthusiasm or to see his vision of the future. Today the future presents as great an enigma as it did one hundred years ago.

Today the successful competitor of the stage coach, pack train, barge, and coasting schooner is itself the prey of competitive means of transportation. The era of mileage expansion is over. The times when privilege and subsidy seemed justified in order to open up the frontier to the settler are replaced by those in which regulation and legislation compel the operation of unprofitable lines, restraint in business activity, and extensive contribution to the public purse in the way of taxes. The communities that once were eager for railroads to lay tracks through their towns, are now severely critical of service and rates. Investments that once were deemed wildly speculative are now the backbone of insurance-company and savings-bank portfolios. Transportation that once was a novel luxury provided through the courage and initiative of individuals, is now considered an inalienable public right, subject to the whims of legislative action. The infant of a century ago has attained maturity, and has been vested with the encumbering mantle of the public interest.

As the brief review of railway history that is one of the features of the *Railway Mechanical Engineer's* centennial number so ably shows, comprehensive plans of coordination and future development were not a feature of the early days. Consolidation eventually took place, and in many instances, notably those which involved other industries than railroading, had to be restrained and dissolved. Integration is the problem of the future. It involves regulation and competition. Two factors of importance need thoughtful consideration: the integrity of investments in railroads, upon which so much of our financial stability rests, and the rationalization of the entire transportation problem, in which the railroads must play a large part. Throughout the opening years of the second century of railroad progress the *Railway Mechanical Engineer* has an opportunity for further service and leadership in this great industry.

Interest in Education

MUCH evidence exists that interest in engineering education is taking a practical form. The Engineering Foundation, for example, has recently issued a booklet, "Engineering, a Career—a Culture," in which an attempt is made to offer information for the guidance of boys of secondary-school age and their advisers in making a choice of future occupation. Columbia and New York Universities, as announced in the daily press and in the November 7 issue of the *A.S.M.E. News*, have recently formed advisory groups of practicing engineers to work with their faculties on matters of educational betterment. A group of engineers, industrialists, and business men in Chicago have given extensive study to a plan for reorganizing the Armour Institute of Technology, and elsewhere in this issue the plan will be found described by the chairman of the trustees' committee, James D. Cunningham. Several references have been made in MECHANICAL ENGINEERING to the plan for the development and the coordination of the engineering profession that resulted in the formation of the Engineers' Council for Professional Development in which the educational interests are well represented and carefully safeguarded. These, and other evidences, are most encouraging.

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

AERONAUTICS

The Odier-Bessiere Clinogyre

THE clinogyre has been installed on a Caudron airplane and consists of a rotating structure with four blades 6 m (19.7 ft) in diameter. This windmill can oscillate on two hubs located at the top of a mast 1 m (32.8 ft) high and slightly inclined to the right. The blades are made of two kinds of wood, spruce on top and chestnut underneath. The plan shape, which is a very fine trapezium with rounded ends, and the various sections are so combined as to obtain a solid having uniform resistance to flexure. The thickness of each of the screws at the hub is about 70 mm (2.75 in.), and the incidence in the neighborhood of the center —3 deg, and at the ends +2 deg. The details of construction of the hub on the actual machine have not been disclosed, but the author reconstructed the design from what he knows generally and what is disclosed in the French patents. Here H and H' represent lifting propellers set at 90 deg to each other. Each one of them has at the center a metal fixture f and f' which holds the rotules R, R' of the vertical shaft. This makes it possible for the propellers to undergo flexure and torsion during their rotation with no other constraint at the hub except that resulting from the action of the rubber pads. Pins e maintained constant the 90-deg angle between the two propellers. They are screwed solid into the propeller H, but go into drilled holes in H' with a play necessary to permit relative movements of small amplitude between the propellers. Under the lower shoulder F_i of the shaft carrying the propellers there are mounted in succession, first, a rubber gasket, next propeller H', then a steel gasket p set between two rubber gaskets, then the propeller H under a rubber gasket, and the top shoulder F_s. The whole assembly is held tightly together between the two shoulders by means of the screw joint C, the direction of rotation and forward motion being such as indicated by the arrows, P_m and P_e represent the profiles of a blade moving forward respectively at the hub and at the extremity of the blade. It will be seen that P_m has a negative incidence and P_e a positive incidence.

The author devotes a considerable amount of space to the presentation of the aerodynamic theory of the clinogyre. The particular feature of the machine is that in a clinogyre rotor the blades are twisted in such a manner that the incidence which is negative near the hub becomes positive at the blade tips. If such a rotor is placed in a wind having a direction perpendicular to the median plane, the portion of the blades near the hub will act as a receiver windmill and will cause the whole assembly to turn, while the extremities of the blades will act as a propeller and will work against the wind. Hence, in the case of a vertical fall the relative wind which is naturally directed from the bottom up produces at the ends of the blades a wind directed from the top down, which will cause a slowing down in the descent. Contrary to what happens in the case of autorotation, clinogyration can take place in one direction only. If a clinogyre rotor is exposed to a wind in a reverse direction it simply stops. In taking off, the rotor rapidly attains a speed of about 300 rpm and keeps in flight at a rotor speed of about 400 rpm, which represents a linear velocity at the periphery of the rotor of about 125 m per sec (410 ft per sec). (P. L. in *L'Aéronautique*, vol 14, no. 160, Sept., 1932, pp. 274-276, illustrated, *d*. Compare M. S. D. in *L'Aérophile*, vol. 40, no. 6, July, 1932, pp. 209-210, illustrated *d*)

The Wilford Gyroplane

THE Wilford gyroplane has a rigid feathering rotor and a fixed wing. It is claimed that the same efficiency of lift of the fixed wing could not be obtained before the advent of the rigid rotor, because it is said to be structurally impossible to allow the rpm of the blades to slow down below a given point unless the blades are rigidly connected to the hub.

The illustrations in the original article show a plane equipped in this way. The text, however, deals primarily with wind-tunnel tests. The air speed in the tunnel is so adjusted as to give constant rpm throughout angles of attack from 3 deg to 90 deg. Below 3 deg the model rotates only because of the difference in drag of the blade moving leading edge first, and of the one on the opposite side moving trailing edge first. When the angle is increased above 3 deg the rotor picks up its normal rpm without outside assistance, and of course starts lifting with the beginning of autorotation, since it is the lift that causes the autorotation. Both wind-tunnel and free-flight tests have shown the change to take place very smoothly and without change in balance.

It is claimed that the minimum drag of the rotor is approximately two and a half times that of a good fixed wing, while the effectiveness ratio or maximum lift/minimum drag of the rigid feathering rotor is over 400. These figures are cited in the original article, and if correct are noteworthy. (Paul E. Hovgard in *Aviation Engineering*, vol. 7, no. 3, Sept., 1932, pp. 12-13, *d*)

APPLIED MECHANICS

Graphical Solutions for Inviscid Flow

THE use of inviscid-flow solutions has long been appreciated in studying the flow past hulls of ships, but recently such solutions have again become prominent in several aeronautical connections as a consequence of the effects of viscosity being confined to a thin boundary layer of fluid at high Reynolds numbers. External to this layer the flow often approximates to the inviscid form, as, for instance, past the front parts of bodies or past cylinders of thin streamlined sections. Calculation of even the inviscid motion, however, in general presents difficulties.

The report describes a method for obtaining by successive mechanical and graphical operations a doublet distribution appropriate to the inviscid flow past a cylinder of any thick section; by introducing a derived contour shape, the method is made applicable to thin sections such as airfoils. The

appendix contains an alternative method which is only applicable to thick sections. Some numerical examples are evaluated, and the accuracy of the results is investigated. (Dr. N. A. V. Piercy in *British Air Ministry Reports and Memoranda*, no. 1473, April, 1932, 16 pp. and 4 diagrams, abstracted through official release, *t*)

Distortion of Thin Tubes Under Flexure

THE method of failure of a tube subjected to flexure depends upon the thickness of the wall relative to the diameter. When this is greater than a certain value, stress conditions alone will determine the maximum bending moment the tube will sustain, and strength calculations may be made by the usual theory of bending. Such tubes may be called "thick" to differentiate them from thin tubes in which another type of failure occurs. The behavior of thin tubes has been investigated mathematically by L. G. Brazier ("On the Flexure of Thin Cylindrical Shells and Other 'Thin' Sections"), who has shown that a progressive flattening of the cross-section at right angles to the axis of bending is associated with an increasing couple: a critical value of this couple is finally reached which produces a stage of instability in the tube. In this note an attempt is made to exhibit Brazier's results in diagrams which enable the essential points to be determined with the minimum of trouble.

The limiting value of the ratio of wall thickness to radius for solid drawn tubes appears to be about 0.2, and the maximum stress obtainable with them not more than 60 tons per sq in. With these limits the material of such tubes will always reach the limiting stress before a condition of instability is reached.

In certain cases tubes from strip metal will have a much lower value of the same ratio, and if the proof stress is 60 tons per sq in. the question of stability will need consideration when the ratio reaches the neighborhood of 0.015. (A. J. Sutton Pippard in *Reports and Memoranda of the British Air* no. 1465, May, 1932, abstracted through official *Ministry*, summary, *e*)

ENGINEERING MATERIALS

Low-Heat Cement for Mass Concrete

THE problem of cracking of cement structures is acquiring increasing importance with the growth in size of modern concrete structures and speed of construction.

Portland cement consists essentially of four major compounds—tricalcium silicate, dicalcium silicate, tricalcium aluminate, and tetracalcium alumino-ferrite—with various minor compounds that are not of importance here.

The calcium silicates are the effective cementing materials, while the other compounds are generally believed to have little or no cementing value. All of these compounds liberate heat during hydration, and the total amount of heat liberated is, in general, proportional to the rate of chemical reaction. Tricalcium aluminate hydrates most rapidly, chiefly within the first day. Tricalcium silicate hydrates less rapidly, chiefly within the first week. Dicalcium silicate hydrates very slowly, chiefly after the first week. Tetracalcium alumino-ferrite hydrates slowly, and since it is considered to have no great cementing value it is believed to be of minor importance. Considering all properties of cement, including volume constancy and durability, tricalcium aluminate is believed to be the least desirable of the four major compounds.

The author gives a comparison of the typical cement used in the construction of dams in the 1890's with that of the typical portland cement of today. The early cements contained a high percentage of tricalcium silicate with its slow development of strength and heat. Because of that and of the comparatively coarse grinding, the heat liberated during the first few days was satisfactorily dissipated, a tendency that was assisted by the slow rate of concrete placement, an important factor in the results obtained. The typical standard portland cement of today contains more than 50 per cent of the fairly fast-reaction compound tricalcium silicate and is finely ground. Compared with the old cements this cement hardens more rapidly and has higher heat generation at all ages. Moreover, the placing of fresh layers of concrete in rapid succession tends to entrap the heat and to aggravate the condition.

An early development in cements for mass construction was the blending of fine siliceous material with cement, quantities of silica up to 50 per cent being interground with the cement. The temperature rise was found to be substantially lower than would have occurred had regular portland cement been used, and there were indications that the siliceous material had cementing value. The factors bearing on the use of such cements where durability and low shrinkage upon drying are important, have not yet been determined.

A good deal of research is cited in the original article. The present trend apparently is toward selection of a cement somewhat similar to the product of early days, but with many of the objectionable properties removed. Cement for the Pine Canyon Dam shows that the mass-concrete cement as compared with typical standard portland cement has less tricalcium silicate, more dicalcium silicate, and a minimum percentage of the troublesome compound tricalcium aluminate. The most striking departure in the new cement is the reduction in content of tricalcium aluminate. The other major difference between the mass-concrete cement and the typical portland lies in the relative percentages of the two silicates. Certain economic factors must be considered in this connection. (R. W. Carlson, Research Engineer, Engineering Materials Laboratory, University of California, in *Engineering News-Record*, vol. 109, no. 16, Oct. 20, 1932, pp. 461–463, *cA*)

INTERNAL-COMBUSTION ENGINEERING (See also Measuring Instruments: Determination of the Upper Limit of Duration of Detonation in Internal-Combustion Engines)

The High-Speed Marine Diesel Engine

THE author sets up what he calls essential and ideal characteristics of the high-speed marine Diesel engine.

In dealing with the subject of high piston speeds, he says that wear of liners is not a function of speed, but is a result of excessive gas pressure behind the rings, inadequate cooling of the upper part of the liner, and high ring temperatures.

As the first example of high-speed Diesels, the author selected an engine (six-cylinder Beardmore) that is not yet on the market. The weight for a unit developing 90 hp at 1800 rpm is 2200 lb in iron with steel connecting rods. The piston speed is 1800 ft per min, which is obtained quite satisfactorily with steel connecting rods. The engine can be temporarily flooded up to the top of the cylinder cowling or just below the fan-shaped air intake of the top of the hood. In this engine the air intake also serves as a crank-chamber vent, and fumes from the latter are drawn into the cylinders.

Rigidity of structure is obtained by the continuity of the main casting from a point well below the shaft line to the

top of the cylinders, also by the provision of a substantial flywheel housing on which the reverse-gear bell housing is mounted. One may digress at this juncture to point out the great advantage, in general convenience and rigidity, of an enclosed flywheel and the general facilities this offers to the designer.

Three-point suspension is employed for mounting, there is a trunnion on the shaft line at the fore end, and there are two brackets in the way of the flywheel housing; these are formed on a banjo plate, and thus the whole weight is distributed to a steel plate and not localized on the main casting. One must always bear in mind that a small vessel in a relatively heavy sea, will, if she is traveling at any speed, impose some formidable loads on the bearers. The attachment can very well be through rubber blocks and rubber bushes, which will give a flexible and insulated mounting to the general benefit of the engine, the boat, and the passengers.

The oil is cooled and filtered, and the dry-sump system is employed. The engine is provided with a slow-running governor, and there is an interconnection with reverse gear that negatives this governor when in astern or ahead, and automatically brings it into action when the gear is in neutral. Because of the hand throttle arrangement, any number of maneuvers can be carried out with the one reverse lever without any danger of the engine raising or stopping through being suddenly loaded when idling. The author would prefer to have seen complete governor control, but it is certainly a problem to adjust the governor from 250 to 1800 rpm without hunting.

It may be suggested that 1800 fpm piston speed is sufficient; that may be so in the majority of cases, but the minority are very important, and it is doubtful whether an engine of this type could sustain a speed of 2500 fpm with security, even if combustion factors allowed the bmep to be held.

The maximum load per square inch on the crankpin bearing at 1800 fpm is 1530 lb. This has been well legislated for, and we can only hope that in due course the designers will proceed somewhat further in this direction.

From this the author proceeds to the consideration of the Petter high-speed two-stroke marine engine. The significant feature of design of this engine is caution. For the piston speed, 1000 rpm has been selected. The engine is rated at a very low output of 50 lb. The pump shaft is chain driven, a comparatively small pump for each cylinder.

The Ruston-Lister four-stroke is built on a good power-unit foundation. It is not fully water-tight as the exposed flywheel very soon produces disorganization in a partly flooded engine room. This exposed flywheel at the fore end is one of the penalties of moderate or low speed and the curtailment of cylinders. The author discusses the matter of flywheels and mentions that many years ago he fitted cowling round the the flywheel of a racing boat and used this for keeping down the bilge water.

The details of the engine show that automobile practice has been adopted for practically all essentials. The author's main criticism of this engine is in connection with the reduction gear, which would appear to depend upon the skill of the boat builder to get it bolted down in line and upon the rigidity of the vessel to keep it so.

As regards the automobile practice adopted, it is stated that the valve rocker levers are mounted on layshafts that are lubricated from the forced-lubrication system and the oil is carried to the ends of the levers. This oil is caught by properly arranged troughways cast on the head and drains back to the crankcase. The camshafts are but large examples of first-class automobile practice, and perhaps more than usual attention has been given to, and progress made with, liners, pistons, and rings.

This four-cylinder engine gives 70 hp at 1000 rpm. It has a bore of $5^3/_8$ in. and a stroke of 8 in., so that we are well above our 100-fpm piston-speed limit, but the bmep rating is somewhat low. The engine is arranged with governor control, though the speed range is somewhat less than might be expected.

The employment of an open reverse gear is criticized, because such gears are a source of possible trouble through neglect.

The Atlantic engine departs from the usual practice adopted for the marine engine and adheres to the overhead valve. In the Dorman engine the reverse gear is said to be of considerable value as the whole of the lateral stress due to the pressure of the brake band has been eliminated by the use of a belt-clutch type of brake. The Allen engine is a moderately high-speed unit for locomotive work, the frame of which is constructed of welded steel, and the author believes that steel construction will prove the turning point in high-speed Diesel design.

The author discusses next high speed ship engines, in particular those of the German small cruiser *Deutschland*. In the German *Bremse*, a vessel 318 ft long with a beam of 31 ft, there are installed propelling engines totaling 26,000 hp in eight units with two shafts. The engines are M.A.N. double-acting two-stroke engines running at 600 rpm with a piston speed of about 1700 fpm. The bmep is high, namely, 91 lb when developing 3550 hp at 600 rpm. The fuel consumption is low and the overall thermal efficiency at overload is 39.6 per cent. Particulars are given also of Fiat engines installed in two Persian naval vessels of 900 tons displacement and a cross-channel boat, the latter having engines of 7500 hp each. Certain criticisms of the *Deutschland* engine are offered.

The author finally refers to the Low engine, existing as yet on paper only in a design intended to cater to the demand for a small high-speed vessel. This engine is a two-stroke, rocking-beam type, with the connecting rod actuated from one end of the rocking beam and the scavenge pump-cum-starting engine driven from the other end, above the beam being mounted two single-acting cylinders with the pistons linked to the ends of the beam.

The project shown is for a cast magnesium-aluminum crankcase, though this has been entirely abandoned in favor of one made on the Stevens welded steel system, and this modification has actually resulted in a saving in weight.

This engine has four cranks and eight cylinders $5^1/_4$ in. in diameter and the stroke is $7^1/_2$ in. The revolutions are 2400 per min, which is equal to a piston speed of 3000 fpm, and the bhp is 600 without supercharge. The overall length of this engine is 6 ft 3 in., including Michell thrust, pumps, and supercharger at the end; the height is 4 ft 4 in. overall; the width 1 ft 10 in.; and the weight approximately 4 lb per hp. In regard to this weight, it is interesting to note that the welded steel frame only weighs 0.326 lb per hp.

In critically considering this engine with its piston speed of 3000 fpm, the author asks what the limitations are to such speed. (A. E. Evans in a paper before the Institute of Marine Engineers, Oct. 11, 1932, vol. 44, no. 10, season 1932, abstracted through proof copy, 18 pp., 15 figs., *c*)

MACHINE PARTS

Rivets in Shipbuilding

IN THE usual type of merchant vessel the cost of rivets and riveting considered as a percentage of the cost of the total iron and steel represents about $7^1/_2$ per cent of the total ma-

terial, and from 35 to 40 per cent of the labor expended upon it. The author begins by stating the requirements of registration societies, such as Lloyd's, and then proceeds to the matter of design of rivets. From tests which the author carried out it was found that even when the depth of head for a $^3/_4$-in. rivet was reduced from the normal figure of 0.525 in. down to 0.400 in., the head remained intact, the fracture occurring in the shank, which had been increased to its effective diameter of $^{13}/_{16}$ in. By adding to this latter depth an allowance of $^1/_{16}$ in. for reduction in driving, it would appear that the normal head could safely be reduced by about $^1/_{16}$ in.

The tests further showed that the countersink required in a plate of 0.36 in.—the minimum thickness for a $^3/_4$-in. rivet—also remained intact, while the shank increased to the effective area fractured. As the head and shank do not increase with the increase in thickness of plates within the prescribed limits, is it not reasonable to conclude that there is no necessity for any change to be made in the countersink? The author is strongly opposed to excessive countersinking, and asks whether it is not possible to leave some small proportion of the plate solid, and by increasing the angle of the countersink, to retain the effective grip on the plate. He illustrates and discusses some of the anomalies which exist in the case of countersinking. He considers hand work superior to that done by the pneumatic hammer. The cost per 100 rivets for pneumatic-power upkeep, replacement of machines, hose, etc., was as much as 2s 6d greater than the cost per hundred for upkeep on the hand tools. The labor cost is such that it is uneconomical to employ machine work where the list price falls below approximately 17s 6d per hundred. The practice of "going back" on the previous rivet is one which is fundamentally sound and should always be insisted upon. The author presents interesting data on the output in riveting with the various systems. This cannot be abstracted because of lack of space. (Robt. Boardman in a paper presented before the North-East Coast Institution of Engineers and Shipbuilders, abstracted through *The Engineer*, vol. 153, no. 3985, May 27, 1932, pp. 590-592, 4 figs., *d*)

MANAGEMENT

A Proposed Forty-Hour Week

ARRANGEMENTS are being made for a trades-union conference in London at an early date to discuss the possible adoption of a forty-hour working week in the engineering industry. The conference has been arranged by the unions affiliated to the Federation of Engineering and Shipbuilding Trades and the Amalgamated Engineering Union. The National Committee of the Amalgamated Engineering Union has agreed to the proposal, and it is understood that several of the allied trades are sympathetic to a shorter working week under certain conditions. The governing body of the International Labor Office at Geneva has called a preparatory technical conference, to be held in January, at which expert delegates representing governments, employers, and employees will investigate the whole problem of working hours and draw up a report upon it. The British unions, while recognizing that such a far-reaching principle can only be applied through national or international action, are of the opinion that home circumstances justify the proposal being discussed by the engineering trade unions, with the object of pursuing a definite line of action before approaching the Engineering and Allied Employers' Federation. (*The Engineer*, vol. 154, no. 4004, October 7, 1932, p. 345, *g*)

MARINE ENGINEERING (See Internal-Combustion Engineering: The High-Speed Marine Diesel Engine)

MEASURING INSTRUMENTS

Determination of the Upper Limit of Duration of Detonation in Internal-Combustion Engines

BECAUSE of their inertia, most of the manographic apparatus now used do not give exact information as to the variations of pressure during the period of combustion in internal-combustion engines, and, particularly, fail to tell anything about the real duration of the phenomenon of knocking. In this research, carried out for the Research Division of the Department of Aeronautics (French), the upper limit of duration of the existence of super pressure corresponding to knocking has been determined experimentally by measuring the impulse communicated by the "knock" to a very light piece.

The work was primarily undertaken to determine the precision of the readings of an electric manograph of the Farnboro type, great attention being given to the lack of data in the region of maximum pressures as given by the curve drawn by the manograph. The following is an explanation of this phenomenon.

The author considers first what happens in the device shown in Fig. 1, when the back pressure, Fig. 2, attains a certain value. In each cycle the valve S rises from its lower seat at the instant when the variable pressure which is being measured exceeds the value corresponding to the ordinate EF, which causes point E to be registered, with a lag which the author found to be negligible for the scale at which the curve is drawn. In order, however, to get a point F really registered on the curve of decreasing pressures, it is necessary that the impulse received during the time period EF by the valve S be sufficient to permit it to reach its upper seat, and that the valve shall remain in contact with the latter during the time τ absolutely necessary in order that the primary current shall attain the lowest value necessary to make the spark gap operate. Had a simple jump of the valve to its upper seat been sufficient to cause the registering of a point, the curve would have been defective. This is the reason why no point is registered by the apparatus if the pressure EF is high enough. This may be checked by calculating, from the extent of the missing part of the curve, of a known quantity considered as the play of the valve between its lower and upper seats.

Let f be the force applied to the valve at a time t after the valve has left its lower seat, x the elongation attained at the end of that time, k and θ constants, and m the mass of valve S. Let it be assumed that during the very short time EF the following relation holds good:

$$f = kt(\theta - t)$$

By integration one derives the following:

$$x = \frac{kt^3}{\partial m}\left(\theta - \frac{t}{2}\right)$$

On the other hand, it is evident that for the first point A inscribed on the curve (Fig. 2)

$$CA = \theta \quad \text{and} \quad DB = \frac{k\theta^2}{4}$$

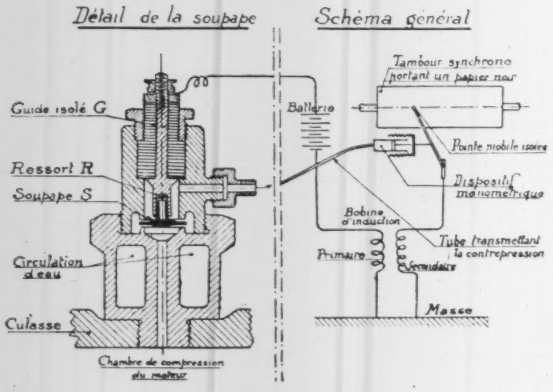
the force being maximum for $\tau = \theta/2$. The expression for the elongation X corresponding to the instant $\theta - \tau$ when the valve touches its upper seat may be therefore expressed as follows:

$$X = \frac{k}{m}\frac{(\theta - \tau)^3(\theta + \tau)}{12} = \frac{4BD}{m} \times \frac{(\theta - \tau)^3(\theta + \tau)}{12\,\theta^2}$$

By measurement (Fig. 2)

$$BD = \frac{4}{9} \times 981 \times 10^3 \text{ dynes, and } \theta = \frac{16}{360} \times \frac{1}{33.3} = 0.00133 \text{ sec}$$

On the other hand, $m = 4$ gr and τ, measured by two different methods, has been found to be to 0.00037 mm, and hence



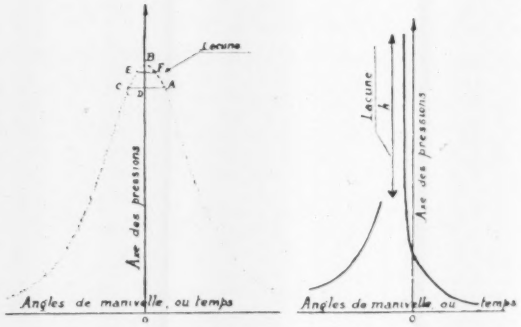


FIG. 1 (LEFT) SERRUYS ELECTRIC MANOGRAPH; FIG. 2 (CENTER) AND FIG. 3 (RIGHT) RECORDS TAKEN WITH THE MANOGRAPH SHOWN IN FIG. 1

[*Guide isolé G* (insulated guide *G*); *Ressort R* (spring *R*); *Soupape S* (valve *S*); *Circulation d'eau* (water jackets); *Chambre de compression du moteur* (compression chamber of motor); *Batterie* (battery); *Tambour synchrone portant un papier noir* (synchronized drum with black paper wound upon it); *Pointe mobile isolée* (movable insulated pointer), *Dispositif manométrique* (manometric device); *Bobine d'induction* (induction coil); *Tube transmettant la contrepression* (tube transmitting the compression); *Lacune* (missing part of curve); *Axe des pressions* (axis of pressures); *Angles de manivelle, ou temps* (crank angles or time periods).]

$$X = \frac{9}{4} \times 981 \times 10^3 \times \frac{(0.00096)^3 \times 0.0017}{12 \times (0.00133)^2}$$

$$= 0.031 \text{ cm}$$

As direct measurement gives 0.03 cm, the check may be considered as being sufficient.

In the case of a motor that knocks, the author calculates the duration of a period of pressure of parabolic type capable of imparting to the valve the same impulse as do the real changes of pressure in the course of the knock. Let therefore $f = kt(\theta - t)$ be the pressure during this hypothetical period of which the duration θ is being sought. We have $x = \frac{k}{m}\frac{t^3}{6}\left(\theta - \frac{t}{2}\right)$; hence $X = \frac{k}{m}\frac{\theta^4}{12} = 0.04$ cm, and since $h = k\theta^2/4$, we have $\theta = (3mX/h)^{0.5}$. By measurement on the diagram it is found that $h = 32 \times 981 \times 10^3$ dynes, and hence $\theta = 0.000122$ sec.

It is found by deduction that the first registered point M is inscribed at a time notably later than τ after the valve has touched its upper seat (viz., at the instant $3\theta/2$). It would appear, therefore, that the duration of the detonation is less than $^1/_{10,000}$ sec. In view of the importance of this result in the matter of theoretical study of knocking, the author has now under construction a manograph having a period of $^1/_{30,000}$ sec, with which he expects to make a more precise determination. (Max Serruys in *Comptes Rendus de l'Académie des Sciences*, May 30, 1932, pp. 1894–1896, 3 figs., *te*)

PIPE

Solutions of Special Problems in Pipe Flow by Graphical Analysis

THIS investigation deals primarily with the flow of water, and as a great majority of problems of this kind encountered in actual practice are found to lie in the region of flow above the critical velocity as derived from the Reynolds expression, the problem is analyzed for this region alone. The values of f, which is the friction coefficient, and of $Vd''s/U$, or the Reynolds number, are computed from data of different authorities and the results plotted. A modified form for the Reynolds equation is derived and its true form determined for the usual conditions corresponding to flow of water. The results obtained for water at 68 F are as follows:

$$f = \frac{0.039}{(Vd'')^{0.168}}$$

and

$$h_f = \frac{0.039}{(Vd'')^{0.168}}\frac{L}{D}\frac{V^2}{2g} = 0.0257\,\frac{L}{D^{1.168}}\frac{V^{1.832}}{2g}$$

where V is the velocity of flow in feet per second, d'' the pipe diameter in inches and D its diameter in feet, g the gravitational constant, and L the length of the pipe in feet.

The various compound and branching pipe systems are considered. (Grant K. Palsgrove in *Rensselaer Polytechnic Inst Bulletin* no. 37, Aug., 1932, 29 pp., 10 figs., *p*)

POWER GENERATION

Solar Power

THE author considers theoretically the industrial possibilities of solar power in such a place as the French Sahara, and briefly mentions an installation for boiling water for bath and kitchen use made by Medical Colonel Pasteur at the hospital in Colomb-Be'char. His apparatus, illustrated but not described in detail, has received a prize from the French Minister of War, and similar units will be installed at other military bases in northern Africa. The remainder of the article

is devoted to a description of the Schumann plant and to Ackermann's article on solar power in the Journal of the Royal Society of Great Britain, and gives charts and tables of insolation in northern and southern Africa. The article would indicate that should it be possible to generate solar power economically in the French Sahara, there is unquestionably a field for its application. (J. Boisse de Black in *La Révue Industrielle*, vol. 62, no. 2278, new series no. 130, Sept., 1932, pp 449-453, 4 figs., *dg*)

POWER-PLANT ENGINEERING

A Steam Engine for Developing Mechanical and Electrical Energy Simultaneously

IN EXISTING plants cases occur where it is desired to retain the shafting but use electric drive for distant parts of the plant extensions and to drive special tools. Since with the increase in size of prime movers the efficiency is increased and cost per unit of energy reduced, it may be desirable to generate the mechanical as well as the electrical energy by means of the same prime mover. Sulzer Bros., Ltd., of Winterthur, Switzerland, do this by the installation of a three-phase generator with an outer pole wheel. In this way no special belt or rope pulleys are required. The principal feature of these generators is that the pole wheel with its poles directed inward revolves around the stator of the generator. It is machined on the outside and can therefore be finished for taking belting or ropes. A plant with such a generator has been installed at the mill of Wener & Nicola, Germania Mühlenwerke, Mannheim. This plant originally had a 1400-bhp compound steam engine, but because of extensions of the plant, the demand increased to 2000 bhp, and it was desired to make the increase in the power-generating unit with the least possible expenditure. This was done by installing a simple non-condensing steam engine with a "Universal" three-phase generator. When running at 87 rpm the plant delivers 600 to 700 bhp to the existing shafting and generates 300 kw electrically. The exhaust steam from the new engine is led to the old engine for developing further mechanical energy, and is then passed to a surface condenser. For transmitting mechanical energy from the new engine a steel belt 10 in. wide running at a speed of about 6000 ft per min has been adopted. (*Sulzer Technical Review*, no. 2, 1931, pp. 21-22, *d*)

A Combination Waste-Heat and Pulverized-Fuel Boiler Unit

THE unit described here is primarily of the type adopted for installation in metallurgical plants. The installation here described has been erected at the Trail Smelter in British Columbia by the Consolidated Mining and Smelting Co. of Canada, Ltd., who are operating there a process for recovering the zinc present in appreciable quantities in the slag from lead blast furnaces. This is done by pouring the molten slag into a rectangular water-cooled furnace and injecting pulverized coal and compressed air beneath the surface of the slag pool. A series of small explosions occurs, resulting in violent turbulence. The CO formed by the incomplete combustion at this stage reduces the zinc combined with the slag as oxide, and causes it to come out as metallic-zinc vapor. This on leaving the bath burns to oxide again along with the remainder of the combustible from the coal, and in order to keep the reducing action as great as possible, the furnace proper is operated with no excess of air.

This slag-retreatment furnace is one of two to be installed and is arranged to discharge into the side of a large brick interconnecting flue approximately 12 ft high by 11 ft wide. From the other side of this flue the gases enter the waste-heat boilers, thence through a long hopper-bottom flue to an economizer, from which they are delivered to a bag house. Two boilers are installed and a third provided for, each having 17,000 sq ft of heating surface.

The increased demand for steam led to the decision to remodel one of the waste-heat units normally held as a spare so as to be able to burn coal also in a water-cooled furnace. As a coal-burning unit, it was required to develop as large a capacity as possible, namely, 4000 hp. It was also desirable to operate at very low ratings on occasion, as it was possible that during the summer the waste heat from the slag-retreatment furnace would almost meet the steam demand. The fuel to be burned was Crowsnest Pass, District of Alberta, with 21.7 per cent volatile and 11,950 Btu per lb as fired. This fuel had been found to give a long flame, so that an important point in the furnace was the provision of ample flame travel. In the final furnace design the shortest possible distance from the burner-outlet center line to the boiler tubes was 22 ft, and the probable flame path was 28 ft. No air preheating is used, but the boiler is fired by a storage system which permits accurate control of primary air.

The waste-heat side had many difficult points in it, for although it was expected that only occasionally would the waste gases be passed through this boiler, still it was necessary, in order to provide reliability, to design the setting as if this gas were to be the steady diet. Most of the decisions on the furnace design, therefore, were made primarily from this viewpoint, and then checked to make sure they would not interfere with pulverized-fuel operation.

The gas carried about five or six tons of solid material per hour, running 50 to 60 per cent zinc, 10 per cent lead, and small amounts of silica, iron, sulphur, etc. This was a concentration of solids much higher than anything encountered in ordinary boiler practice, for it amounted to 7 per cent of the furnace gas by weight. (In a standard pulverized-fuel furnace, burning coal of 20 per cent ash content, this figure is about 1.8 per cent.) The low excess air resulted in such a long flame and high temperature that the gases were found entering the boiler as high as 2700 F. This combination of high temperature and heavy dust burden furnished the essential materials for a slag problem which would be major or minor, depending on the exact characteristics of the dust itself. The zinc fume comprising the major portion of this dust was not easily fusible, but the remainder had unfavorable characteristics. There were particles of lead slag blown over from the bath and from the addition of coal slag.

The mechanism of the building up of deposits on the brick walls is further explained, and the various elements of design discussed and illustrated in the original article. In the final design the gas enters as low as possible, which has been achieved by dropping to the lowest possible point the upper header of the slag screen and by finning the slag-screen tubes, thus making them act as a baffle. Then to increase the water-cooled-wall area the riser tubes from the upper side-wall headers were bent back inside the furnace and run vertically up the furnace face of the brick walls. These changes in the design brought the flow of the waste gases more in line with ordinary boiler-furnace conditions. Due to the scanty information available covering gases with such high dust content, exact calculations of the radiant-heat absorption in the walls could not be made, but in a general way it was known that in a boiler furnace with horizontal firing and bare tube walls the boiler tubes do not slag up unless the flame washes them heavily for

a long period. The lower part of such a furnace is unquestionably full of gas-carrying molten slag, and the furnace bottom may even be a pool of slag. This freedom from slagging troubles has been secured even with coals whose ash softens at 1800 or 1900 deg. The boiler, therefore, would probably be safe against slagging unless the low excess air in the slag-retreatment boiler resulted in the flame being so long that it entered the boiler tubes still burning. This was unlikely in this instance on account of the great length of the connecting flue providing ample travel to complete combustion, but it is a point which should not be forgotten when considering such cases generally; cases are known where the flame is still burning briskly in the second pass of the boiler, and in these something more drastic than a slag screen and water-cooled walls is required to eliminate slagging.

A rather unique precaution against accumulation of large slag masses on the walls which might fall on the ashpit screen and wreck it was resorted to in the form of side walls for the insertion of water-cooled beams under the upper row of tubes to form a solid grillage which would be safe against falling slag. This was not the only unconventional feature of the installation here described.

When it came to operating, it was found that at high ratings the unit was easy to run, but considerable trouble developed at low loads. This was, however, remedied, although the efficiency at very low ratings is still very poor. There is no difficulty now in operating on coal while the boiler is handling waste heat, and it was found possible to cut off the coal supply and start it up again at will.

Among the conclusions, the following are particularly emphasized. Water-cooled-wall construction can be successfully applied to cope with slag adhesion or refractory erosion. There are good grounds for believing that, given a specific case, a boiler and setting can be designed which can operate continuously as long as the furnace can. It is believed that in a new installation, where free scope is allowed, this can be assured even with the most unfavorable conditions. (W. H. D. Clark, Combustion Engineering Corp., Ltd., Montreal, in *Combustion*, vol. 4, no. 3, Sept., 1932, pp. 20-26, 4 figs., *dA*)

Fire in a Belgian Central Station

EARLY in October of this year a disastrous fire occurred at the Brussels Power Station. This station has an annual output of from 60,000,000 to 70,000,000 kwhr, with a winter peak of some 40,000 kw. It contained nine turbo-alternators of 6000 kw capacity each, and two turbo-dynamos each of 1500 kw, besides converting machinery. At the time of the accident the load was very light. Early in the afternoon the operator noticed that some oil on the high-pressure pedestal had caught fire, but before he could get to it, a jet of flaming oil shot upward and set fire to the roof, which was almost instantly in a blaze from end to end. No one was killed, and only a few minor personal injuries were reported. The roof came down, but the traveling cranes, one of ten tons and the other of thirty tons capacity, were against the end walls of the station at the time and so escaped from being precipitated to the ground with the burning roof.

There was no explosion of either a turbine or a generator, nor did the whole of the oil in the turbines get on fire or contribute in any way to the disaster. The official report has not yet been published, but the following facts are available. The turbo-generator at which the fire originated had been running all day, and the end pedestal of the machine was wet with lubricating oil. The pedestal being close to the high-pressure end of the turbine, was naturally fairly warm, and it is possible that the oil became ignited by a short-circuit on the leads to a small motor belonging to the speed-regulating gear. Before the attendant could reach the machine a screwed plug in the oil-pressure system blew out, and a jet of oil under a pressure of about 60 lb per sq in. was projected vertically upward. The jet instantly ignited, burning, as one witness described it, like a naphtha torch and giving out such heat that the men had to shield their faces with their hands. The flame reached the wooden roof, of double construction and about twenty-five years old, and nothing then could save the station. No other oil, so far as is known, caught fire, and the appearance of the basement confirms this view.

Until the debris of the roof has been cleared away it is impossible to ascertain what damage the machinery has suffered. Three bedplates at least are cracked, but little other external damage of a serious nature is noticeable. The rotor of a turbine which had been removed from the casing before the accident appeared little worse for what it had undergone. The stator of the alternator of the same machine had its insulation badly charred, but the other alternators may possibly have been sufficiently protected by their end shields. None were of the closed-ventilation type, however, so that the tops of the stator cores were exposed. What hope there is for the machinery lies in the fact that the fire, though exceedingly fierce, was very quickly over, almost like the blaze of a pile of straw. Men were at work examining one machine within twenty hours of the disaster, and it was thought possible by the station engineers that it might be got running again within a week. (*The Engineer*, vol. 154, no. 4004, Oct. 7, 1932, p. 360, illustrated, *d*)

The Generation of Steam by Blast-Furnace Gas

BOTH the Lancashire and water-tube types of boilers have been successfully used for supplying rolling-mill engines. The Lancashire boiler has a large heat capacity when filled to normal working level, the fall of pressure in the steam main resulting in the production of steam by evaporation of some of the stored water. Water-tube boilers respond rapidly to demand and will maintain nearly constant pressure. From an analysis of the characteristics of blast-furnace gas as a fuel it would appear that the ordinary gas-fired Lancashire boiler provides one desirable feature, the radiant-heat-absorbing surface round the flame, but fails to provide the remedy for the resultant very low flame temperature which is sometimes insufficient even to ignite the incoming gas. The same boiler or a water-tube boiler fitted with a brick-lined precombustion chamber represents a case of excessive concentration on the maintenance of the flame temperature with insufficient attention paid to the problem of transmitting the heat rapidly to the water in the boiler. The ordinary water-tube boiler affords a fair compromise, and usually results in a slightly improved thermal efficiency.

The solution of the problem whereby the flame temperature may be maintained while at the same time rapid heat transmission to the boiler heating surface is effected, is undoubtedly the preheating of the air of combustion. For a calculated flame temperature of preheating the air and a gas temperature assumed constant at 400 F, and an air temperature increasing from atmospheric temperature to 500 F, it is found that the calculated flame temperature is raised from 2387 F to 2579 F, a 10 per cent increase which will increase the radiating power of the flame by 30 per cent. In no case will these temperatures actually be attained, as heat is lost by radiation from the flame before combustion is completed; but the calculations serve as a basis of comparison.

The result of adding heating surface in an air heater will be to increase considerably the output of the boiler for a given amount of boiler heating surface. The value of this lies in the fact that the cost of air preheaters, which may be taken as approximately 2s per sq ft of heating surface, compares favorably with a cost of 10s or more per sq ft of boiler heating surface, and there will be obvious economies in capital expenditure if the rating of the more expensive plant can be suitably increased by the addition of less expensive items.

Unlike the case of pulverized fuel or gas firing in blast-furnace-gas-fired installations, there are difficulties in heating the air above about 400 F owing to the fact that the weight of waste gases is about double the weight of the air supplied for combustion.

As a general rule it may be stated that it is uneconomical to provide boiler heating surface in excess of that necessary to cool the gases to about 600 to 650 F. There would seem to be considerable scope for a boiler layout in which both the gas and the air are preheated. This is done in open-hearth furnaces and in soaking pits, and there seems to be no reason why this principle should not be applied to blast-furnace gas-fired boilers.

There is a record of the preheating of blast-furnace gas for boiler purposes in America, where the gas was passed through a tubular type of heater, composed of 4-in. boiler tubes, and heated by the waste gases from the hot-blast stoves. In this case, however, the degree of preheat was comparatively slight, the gas temperature being raised from 69 F to 104 F, and the chief object in the procedure was to evaporate the liquid moisture entrained by the gas during the wet-washing process. If the hot-blast stoves are efficiently operated there should not be sufficient heat left in the waste gases to make it profitable to introduce the unavoidable complication of this type of preheating.

The matter of temperature of waste gases is extensively considered. The maintenance of correct air-gas proportioning is greatly facilitated if the air is supplied under an easily controlled pressure, and this would be still further enhanced if the gas were similarly controlled. The result of the combustion of pressure-controlled air and gas in correct proportions in a suitable burner would be an intense flame of small dimensions which would not depend for ignition on heat radiated from incandescent refractories, and could be almost entirely surrounded by water walls in the manner of modern pulverized-fuel-fired boilers, giving a high rate of evaporation per square foot of boiler heating surface, with the result of a compact and comparatively inexpensive boiler for a given duty.

An interesting development of this trend of design is the Wood steam generator, in which the boiler is definitely divided into two parts, a water-cooled furnace in which the products of combustion transmit heat to the boiler heating surface almost entirely by radiation, and a bank of water tubes, at the back of the furnace, which are "scrubbed" by the gases passing parallel to the tubes in a single pass.

Suitable safety devices would have to be provided lest a deficiency in gas supply should cause the fans forcing the blast-furnace gas through the preheater to the burners to produce a considerable suction in the gas main. This might cause sufficient air leakage into the main to form an explosive mixture A control to slow down or stop the fan motor when the pressure in the gas main fell below atmospheric pressure by more than a predetermined amount could easily be incorporated.

The author discusses next the problem of storage of blast-furnace gas and the allied problem of providing supplementary steam where there is a deficiency of blast-furnace gas. In many cases considerable operating economies accrue from the provision of a gas holder of adequate capacity. However, the development of modern air-gas regulation is such that the boiler efficiency is so well maintained in the absence of a gas holder that its installation must be a matter of general plant policy and cannot be justified merely as an aid to improve boiler performance.

As regards coal firing as a stand-by to the gas supply, the author refers to the unsatisfactory way in which this is usually done. Where Lancashire boilers are used he recommends retaining some boilers as coal-fired units and equipping others solely for gas firing, leaving only some of the boilers with both grates and burners. Quick raising of steam in the banked coal-fired boilers would be facilitated if preheated air were available for bringing the banked fires up to full combustion rates, although arrangements would have to be made for by-passing a certain amount of cold air direct from the forced-draft fan on the boiler battery to mix with preheated air under the coal grates, as the fire bars would not stand an air preheat of 400 F.

In the case of water-tube boilers, usually fewer in number and of larger individual capacity, this subdivision of the boiler units is not practicable, and there are strong reasons for installing pulverized fuel as the supplementary firing agent. This merely requires additional burners without any grates or stokers, and the air supply to the pulverized fuel can be controlled with nearly as much accuracy as for the gas fuel itself. The result is that the boiler can be operated on gas only, on pulverized fuel only, or on a combination of both, with little variation in thermal economy. Since the operating hours per year of the pulverized-fuel plant will be comparatively few, low capital investment will take precedence of low running costs or very high burner efficiency; but reliability is, of course, essential in a stand-by plant, and a direct "unit" system of pulverizing will be preferred to any of the more complicated systems in which one or more mills serve several boilers through pulverized-fuel mains.

At one works in England where pulverized fuel is thus employed in combination with blast-furnace gas under water-tube boilers, the author has seen the pulverizer started up and the entire load on the boiler carried on this fuel (the gas being shut off) within a minute, the figures obtained for CO_2 in the waste gases indicating an efficiency quite equal to that with gas firing.

The disadvantage inseparable from the use of stokers, even of the traveling-grate type, as an auxiliary to gas firing is that to protect the grate surface when gas firing is employed the grate must be covered with ash, so that full output on coal firing cannot be attained until the grate has moved sufficiently to clear off this ash and cover the full area with coal in the normal way. (A. F. Webber, in a paper before the Iron and Steel Institute, Sept. 14, 1932, abstracted through *Mechanical World*, vol. 92, no. 2387, Sept. 30, 1932, pp. 320–322, *p*)

A "Rotary Boiler"-Turbine Installation

THE essential features of the boiler used in this installation are as follows: In the first place, the boiler is divided into a number of U-shaped tubular elements attached to a hollow central shaft and rotating therewith, the heat being supplied from the outside to these elements and preferably at the bottom. Second, the water is admitted to these rotating elements through orifices in the shaft and is projected outwardly by centrifugal force. The water therefore acts as a piston and increases the compression of the steam, permitting the generation of high-pressure steam without the use of conventional feedwater devices. The experimental unit is shown in Fig. 4. It consists of a hollow shaft and a number of U-shaped tubes

attached thereto, the shaft being provided with orifices to permit feeding water into the tube elements. These latter are solidly attached to the shaft and spin therewith.

When water is supplied through the shaft, it is thrown to the periphery of the tubes. The water is delivered to the tube *a*, while steam is generated in tubes *b*. The heat in the experimental unit is supplied by a gas burner, and the fanning action of the rotating tubes helps to draw the gases into the casing of the boiler and deliver them to the exhaust connections. Fig. 5 shows the increase of pressure resulting from the use of centrifugated water in a model 710 mm in diameter. Notwithstanding the small size and simplicity of the model, steam pressures of 30 atm have been obtained at 2200 rpm. This process is said to permit the generation of higher steam pressures without the employment of a feed pump. Furthermore, the increase of pressure does not involve the consumption of any outside energy. It is produced by the transformation of water into steam. The process is essentially similar to that of the generation of steam in a boiler with natural circulation. From this the author proceeds to a description of what might be called a "one-piece" boiler-turbine unit. Apparently no such unit has yet been built, but Figs. 6 and 7 show the general design. The water is delivered through the hollow shaft (right, Fig. 6) and flows through it into the preheater tubes *a*. In these the water is projected outward and subjected to pressure in the longitudinal tubes *b* and the radially disposed ones *c*. Steam is generated in the tubes *b* and *c*, and because of the difference of the centrifugal forces acting on the steam and water a difference in pressure is produced which, assuming the presence in tubes *c* of a given content of water and a peripheral speed of 160 meters per sec, corresponding to 3000 rpm, creates in the collector *d* a pressure of about 120 atm. The steam then passes through the superheater *e* into an insulated collector tube *f*, shown in the figure at the left end of the hollow shaft, and thence flows into the rotating nozzles of the high-pressure turbine *g*. From here the steam, which has lost a part of its pressure, goes to the intermediary superheater tubes *h* surrounding the fire chamber.

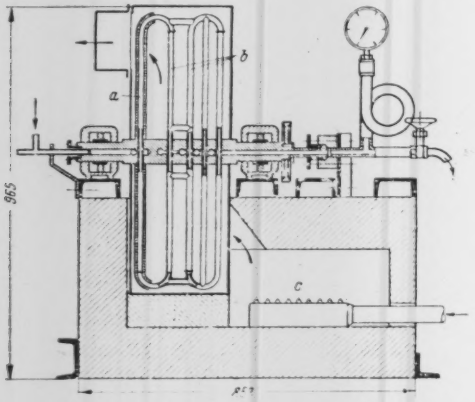


FIG. 4 LONGITUDINAL SECTION OF EXPERIMENTAL INSTALLATION (*a*, waterfeed tubes; *b*, steam-generating tubes; *c*, gas burner.)

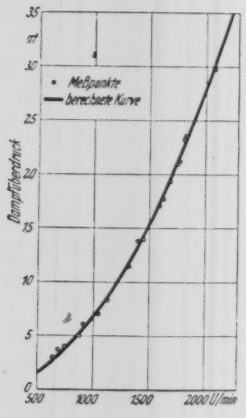


FIG. 5 PRESSURE RISE IN THE EXPERIMENTAL STEAM GENERATOR

(Ordinates, steam-gage pressure; abscissas, rpm; *Messpunkte*, points determined by measurement; *berechnete Kurve*, calculated curve.)

The steam generator shown in Figs. 6 and 7 is assumed to be capable of evaporating 18 metric tons per hour while working at an efficiency of 85 per cent. By expanding the high-pressure steam from 120 atm and 380 C (716 F) to a pressure of 25 atm the high-pressure turbine should generate about 850 kw. To drive the steam generator as well as to provide fresh air and the turbulence work on the heating surfaces, it will be necessary to consume about 200 kw, so that 650 kw will be delivered as useful work. The 25-atm-pressure steam will be heated to 450 C (842 F) in the intermediary superheater. The difficulties in operating the intermediary superheater encountered in conventional super-pressure installations are said to be eliminated here because of the fact that the boiler and high-pressure turbine are built as a single unit. Such an installation requires no regulation of either steam or water circulation. The water is supplied to the boiler at low pressure and the amount admitted is governed by the output of steam, only the heating being regulated. The water admitted controls itself automatically as its delivery is caused by the steam generation. The whole auxiliary equipment used with super pressure steam may therefore be eliminated entirely, and since the energy stored in the installation is extremely small, all danger of explosion is practically eliminated and rapid control of output by changes in heating made possible.

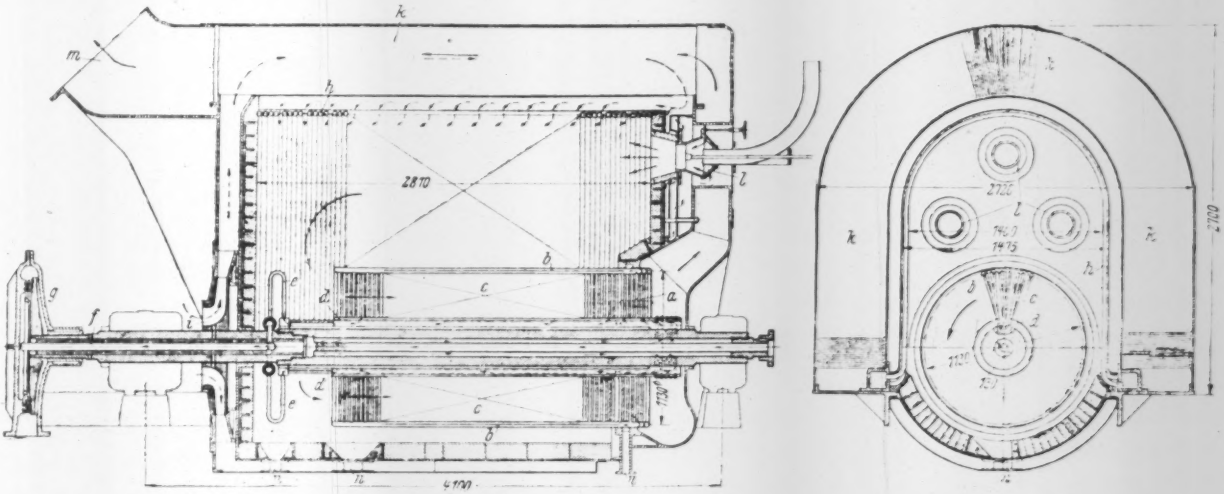
Because of the complete evaporation of the water fed into the boiler, only very pure water must be used. The water circulation in the installation must therefore be such as to keep the losses as low as possible. In this respect the elimination of high-pressure joints, valves, and piping is a very favorable factor.

The author discusses next the influence of high peripheral velocity of the boiler-tube assembly on the heat transfer. Measurements of the transfer of heat have been carried out on the model. At 1500 to 1600 rpm the coefficient of heat transfer was found to be as high as 250 kg-cal per sq m per hr per deg C difference (51 Btu per sq ft per hr per deg F difference). It may be assumed that with higher rotary speeds and a greater velocity of the flow of the compressed gas a still better transfer of heat will be effected, so that the heating surfaces need only be one-fifth or one-sixth of what they are in present boilers. Of course, such an increase in transfer of heat predicates a greater expenditure of work in turbulence, which is expected to amount to about 2 per cent of the useful energy. Since with the boiler here described no energy is required to drive a feed pump, the total consumption of energy by auxiliaries is said (on the basis of calculation) to be smaller than in the case of conventional steam generators.

The rotating steam generator produces a circulation of gases because in rotation it throws the air to the periphery and draws fresh air into the central portion. The flue gases are therefore violently projected outward at the exhaust connections, while the hot gases are sucked in from the other side. This effect may be increased by giving the generator elements a screw-like design. The efficiency of moving the flue gases need not be considered here, since the work thus not employed is used to improve the efficiency of heat transfer by producing a turbulence at the surfaces that take up the heat. This is different from what takes place in conventional boiler tubes. The installation of the fresh-air blower on the shaft of the steam generator makes the moving of the air and flue gases in the boiler entirely automatic. The air preheater can be placed inside the furnace jacket, thus eliminating all fresh-air and hot-air piping. The dust and ash particles which reach the

heating surfaces are automatically thrown off by centrifugal force. Moreover, the rotor is externally closed like a drum and is free to pass only flue gases, while particles of ash and dust are thrown out. These latter are collected in troughs on the lower casing jacket and can be blown out with a small flue-gas blast. Only two or three per cent of the total amount of flue gases is needed to blow away the ash. The heat in the flue gases can be taken up in a separate heat exchanger. As only soft ash particles come in contact with the heating surfaces, the wear of these latter is very slight

Great care will be naturally required in designing a steam generator rotating at 3000 rpm. The economy of an installation such as that described depends essentially on the first cost. It would appear that because of the compactness of the unit there will be considerable saving in the cost of installation due to absence of steam piping, numerous boiler auxiliaries, feed pumps for high-pressure steam, etc. The author claims that his installation is some 60 per cent cheaper to build and put in than a conventional unit of the same size (18 metric tons per hr). In fact, he claims that his costs for a high-pressure unit are lower than the present cost of a low-pressure unit of the conventional design for the same output. The structures containing the unit will also cost less because of the smaller floor space required. (Dr. Ing. Heinrich Vorkauf, in *Zeitschrift des Vereines deutscher Ingenieure*, vol. 76, no. 41, Oct. 8, 1932, pp. 988-990, 5 figs., *dA*)



FIGS. 6 AND 7 DESIGN OF A ROTARY STEAM GENERATOR WITH HIGH-PRESSURE TURBINE

(Speed, 3000 rpm; steam generated, 18 metric tons per hr; pressure at the rotating nozzles, 120 atm; steam temperature at the nozzle entrance, 380 C; end pressure in high-pressure turbine, 25 atm; temperature of intermediary superheating, 450 C = 842 F; available output at coupling, 500 to 600 kw; heating surfaces: evaporation, 66 sq m (710 sq ft); intermediary superheater, 35 sq m (377 sq ft); *a*, water feed tubes; *b*, connecting tubes on periphery; *c*, evaporator tubes; *d*, steam collector passage; *e*, high-pressure superheater; *f*, insulated collector tube; *g*, high-pressure turbine; *h*, intermediary superheater; *i*, fresh-air blower; *k*, air preheater; *l*, burner; *m*, flue-gas connection; *n*, ash and dust hopper.)

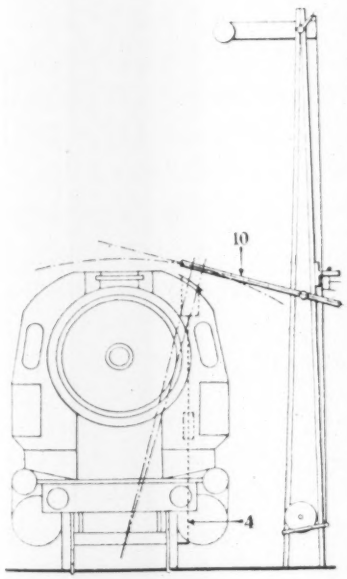


FIG. 8 GENERAL ARRANGEMENT OF KOFLER AUTOMATIC TRAIN-STOP MECHANISM

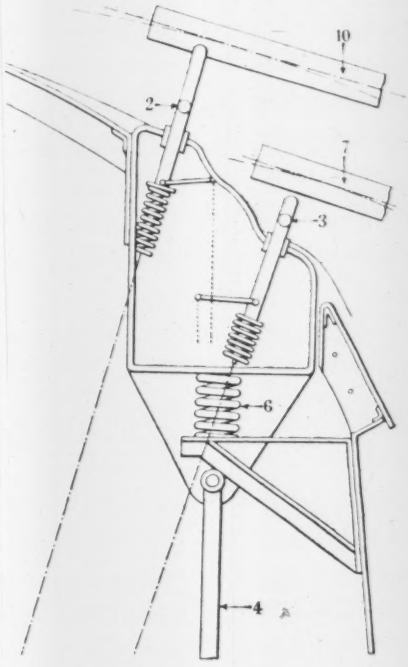


FIG. 9 DIAGRAM SHOWING ACTION OF SIGNAL ON PASSING TRAIN, KOFLER SYSTEM

RAILROAD ENGINEERING

The Kofler Automatic Train Stop

THIS is an old mechanical system developed by an Austrian engineer, Kofler, and is at present on trial on the Isar Valley line in the neighborhood of Munich. In this apparatus an engaging or trip piece alongside the line comes into contact with a corresponding element on the train and moves it in such a way that it gives a warning or applies the brakes as may be desired. The engaging apparatus is here placed in the overhead position, i.e., over the train, and to maintain the drag and train elements in correct register with one another at all times independent of the motion of the vehicles, the inventor has placed his

train elements in such a position and made them of such shape that the oscillatory motion of the train moves them in a radial path, the drag element being arranged tangentially to that path.

Fig. 8 shows the general arrangement of the principal parts of the device. Two spring-loaded bows, 2 and 3, seen end on in Fig. 9, when depressed by the striking elements 10 and 7, operate the absolute and warning mechanisms on the train. The strikers 10 and 7 are respectively operated by stop or distant signals, to the mechanism of which they are attached. In order still further to make certain of correct action at all times the inventor carries the train mechanism, by means of the supporting rod 4 and buffer spring 6, on the axle boxes and not on the body of the locomotive or car. The actual effects produced by the depression of parts 2 and 3 can be varied as desired.

A modification of the signal mechanism has now been constructed in which the striking element, having once acted on a passing engine or train, automatically moves clear of the construction gage, so that it cannot be damaged by protruding loads or other obstructions. It resumes its position at the next manipulation of the signal, or may be reset by hand. By this means the probability of damage to the equipment is reduced to a minimum.

Special anchoring arrangements are also included in the design, to insure that the track and the signal, with its striker mechanism, always remain in the same relative positions. The working of the Kofler apparatus is thus very simple and largely resembles that of other mechanical train-stop systems, but it is claimed by the inventor that the design of the parts is such that the following advantages, among others, are obtainable: (1) Positive action under all conditions; (2) durability, accessibility, and easy replacement of parts; (3) small wear and tear; (4) no violent shocks; (5) ability to transmit several signals or control effects to the train; and (6) ease of combination with any type of signal. (*Railway Gazette*, vol. 57, no. 9, Aug. 26, 1932, pp. 249–250, 2 figs., *d*)

SPECIAL MACHINERY

Wire Screens

THE cross-sections of four different screens are shown in Fig. 10. The oldest form is the double-crimp screen, the main drawback of which is that it lacks rigidity in the larger openings of light wires. In order to eliminate this defect the wire is frequently crimped between intersections, which gives a construction known as the "intermediate crimp." Such a screen is, however, quite rough, and to make a smoother cloth the intermediate crimp is used in the cross-wire only. Still another way of making a rigid screen with a fairly smooth surface is known as the "high and low tooth." Recently a new type of screen has been evolved known under the trade name of "Flatlock." In this screen no attempt is made to utilize more than one surface of the screen as a wearing surface, and this is made as flat as practical. Two crimps of the same depth as used for "intermediate crimp" are put in the wire, with a set of shallow crimps in between these major crimps. In this way every even-numbered warp wire is rigidly locked in a deep trough of the even-numbered shute wires, and every odd-numbered warp is locked by an odd-numbered shute. The shallow crimp acts as an intermediate lock which may be made as firm as the lock of the double crimp or "high and low tooth" crimp. The resultant screen is one with a flat upper surface and rough lower surface. In the oblong meshes, which are so widely used, the warp wires are made in the "Flatlock" crimp and the shute or cross-wires of ordinary crimp.

The author discusses next the question as to how small the wire can be made. The wires must be large enough to support the load they have to carry without bagging or taking a permanent set. The larger the wire used, the longer it will take to wear it down to the point where it will fail. The practice of ordering screens with excessively large wires in an endeavor to get longer life is criticized.

As the ratio of the size of wire to opening increases, the free opening decreases and the maximum screening tonnage is decreased. If the equipment was oversize to start with, this decrease in tonnage passes unnoticed. Later on, if production increases, more capacity must be provided. Usually additional equipment is purchased, while a change of screens would have accomplished the same results at no expense. The larger size of wire costs more money. A square-mesh screen with $\frac{3}{4}$ in. openings made of No. 4 (0.225 in.) wire will cost approximately 50 per cent more than the same screen made of No. 7 (0.177 in.) wire. In the second case the free area is 65 per cent and in the first case, 58 per cent, or a loss of roughly 11 per cent. Thus the cost of 100 sq ft of free opening using No. 4 wire costs approximately two-thirds more than the same amount

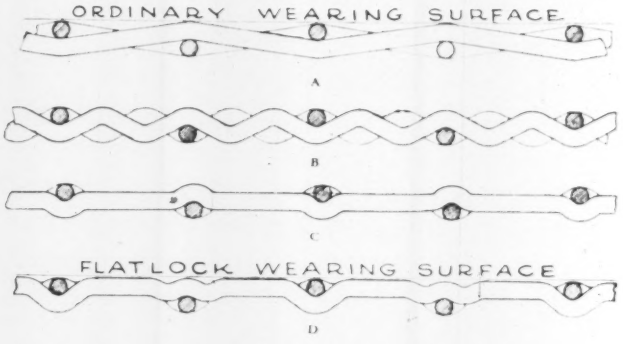


FIG. 10 WIRE SCREENS

(*A*, ordinary wearing surface; *B*, intermediate crimp; *C*, high- and low-tooth; *D*, Flatlock.)

of free opening when No. 7 wire is used. The increase of wire size is neither practical nor economical, if the same result can be obtained in some other way.

Attempts to use harder wire have met with difficulties. Fatigue stresses have been the undoing of high-manganese steel in vibrator screens, but alloy wire of other kinds has been quite successful.

The various types of wire do not respond to stresses in the same way. In the double crimp we have a long incline suddenly stopped by a full wire. As rock passes over the screen these wires are bumped out of place and worn thin to the breaking point. The intermediate crimp presents a series of peaks to the rocks, but the cross-wires are fairly well protected. Such a screen will take some time to wear down, but when it does it will be at the high points, or on the crimps, which is the weakest point in the fabricated wire. The "high and low tooth" crimp has a section of straight wires; but it also has those objectionable humps which have no protection at all from the impact of the rock. The crimps are only half as deep as in the intermediate crimp, making it twice as easy for the cross-wires to be knocked out of place, and there are also only half of the high points to be worn down. In "Flatlock" there are no unprotected high points. There are only slight depressions over which the rock slides smoothly. The cross wires are completely buried in the large depressions and are not subject to any violent impacts or loads. (J. W. Galloway

in the *Canadian Mining Journal*, vol. 53, no. 8, Aug., 1932, pp. 360–362, 3 figs., *cd*)

An Electro-Farming Conference

FOR several years the British Electrical Development Association has held a conference at the Royal Agricultural Show with the object of impressing upon farmers the economic advantages of the application of electricity to all operations on the farm. It is recognized, however, that these conferences do not appear to reach the farming community as effectively as they should do, and that greater cooperation is necessary between the supply authorities dealing with rural areas and the farmers. It was therefore for the purpose of discussing the more technical details of the subject with the farming interests, and also with the supply and manufacturing side, that a one-day electro-farming conference was held at the Greater Felcourt, East Grinstead, all-electric farm of Mr. R. Borlase Matthews on Saturday, October 8.

The matter was discussed from two angles, viz., (1) what was referred to as the "bread and butter" electrical equipment which the farmer will install when he first uses electricity, and (2) the larger electro-farming equipment, such as the 150-hp hay-drying and disintegrating plants, the 250-hp electric plow, the 30-hp rain cannons which are being used on the Continent, electric soil heating, etc. The conference was opened by the display of a number of films of electro-farming operations on the Continent and in this country, with a general description of the types of apparatus and their applications. While it was the general view that there should be an individual motor drive for each separate piece of farming apparatus, it is realized that in order to induce the farmer in this country to take up electricity for many other purposes than electric lighting, it will be necessary at first merely to change from oil or other form of power to electricity for driving the countershaft to operate a number of machines. There is still a great hesitancy on the part of farmers to make even this change, and it was something of a surprise, after extensive propaganda on the subject, to hear a representative of one county agricultural authority say that he was at a loss what to reply to the farmer who inquired as to whether it would pay him to adopt electricity. Certain figures were therefore given during the discussion indicating how the adoption of the individual motor drive not only makes savings which pay for the cost of the apparatus, but also enables still further savings to be made which render the operation more economical from every point of view.

Among the technical points that were raised was the applicability of the motors now made by British makers to farming operations. It was contended by Mr. Borlase Matthews that none of the three-phase squirrel-cage motors, for example, turned out by British firms are really suitable for farming work. The conditions laid down were that such motors should be capable of being left out in all weathers with no other covering, perhaps, than an artificial-manure sack, that they should be fool-proof, capable of operating safely in an explosive atmosphere, and so on. The reply of the manufacturers, it was alleged, had been that they could not modify their standard lines for the sake of a few farmers, and that in any case these standard motors did farming operations quite satisfactorily. Against this attitude was mentioned what has happened on the Continent. There, as the result of concentration upon the requirements of the farm, the large electrical manufacturing firms are turning out as much as 80 per cent of their motors specially designed for agricultural operations.

The other technical problem which received discussion was whether supply to farms should be on the single-phase or three-phase system. Mr. Borlase Matthews favors the three-phase system for various reasons, chief among which is the very much lower cost of the three-phase squirrel-cage motor. There are, however, advocates of the single-phase system, their view being that a single-phase line is cheaper to install, and that when the complete motor equipment is taken into account there is not very much difference between the cost of a single-phase and a three-phase motor. The portable electric motor was not very much favored. (*The Engineer*, vol. 154, no. 4005, Oct. 14, 1932, pp. 377, *g*)

TESTING AND MEASUREMENTS

The Testing of Rope Wire and Wire Rope

THERE is still a divergence of opinion as to the interpretation of results embracing the fatigue properties of wire. The present article describes test methods for fatigue testing of rope wire and wire rope. The apparatus uses the rotating-cantilever-beam principle. The specimen is rotated axially and subjected to a constant deflection or bending moment. Cyclic stress reversals from a maximum compression through zero to a maximum in tension are thus produced. The adaptation of this fatigue-test method to the measurement of abrasion resistance of wire has been worked out.

As the inherent advantage of using wire rope lies in its flexibility combined with high strength, the life of a rope subject to alternate bending is of interest to the rope designer as well as to the user. Several extended researches have been conducted on this subject by rope manufacturers, but little information is available in the literature. The work conducted by the British Institution of Mechanical Engineers and Dr. Woernle are by far the most comprehensive researches reported. Neither group has concluded its work.

The testing apparatus developed for this purpose is described in the original article and a classification of the types of wire breaks is given, as follows:

Crown-Wire Breaks. Breaks visible on the outer strand crowns.

Valley Breaks. Breaks occurring at a point adjacent to strand contact accompanied by wire nicks and usually caused by core collapse or inadequate core.

Inside Breaks. Breaks occurring on the outer series of wires, but adjacent to the core, not normally visible.

Inner-Wire Breaks. Breaks occurring in the inner series of wires, not normally visible.

Core-Wire Breaks. Failure of the core or king wire.

The effect of varying the tensile load upon the life of traction steel elevator ropes and the effect of varying the torsional stress upon the life of traction steel elevator ropes is shown in curves in the original article.

It is common but condemned practice to equalize the length of parallel elevator hoist ropes by twisting or untwisting the ropes during installation. Building managers are then greatly surprised when one or two of the ropes are in much better condition when removed than are the others. The application of external torsional stress is often a contributing factor.

Brief reference is made to the "doughnut" or "smoke ring" wire-testing machine and to the Woernle machine, as well as fatigue testing of small flexible cables, such as are used for aircraft control by the War and Navy Departments.

The correlation of properties of components to the performance of the complete structure is the ultimate aim of all testing. The correlation of fatigue properties of wire to the life of rope in the field is an extremely hazardous undertaking because of

the constantly changing conditions, but it is evident that, other things being equal, increasing the fatigue properties of the wire will improve the life of the rope.

An ideal rope should last as long as a single wire when subject to the same bending stress before a single wire fails. Fig. 12 in the original article shows the effect of preforming on the life of a single wire in a rope as compared with the endurance properties determined on the single wire.

The "life" curves of the preformed rope and single wire are practically parallel, whereas the data for the non-preformed rope are erratic and the "life" curve departs considerably from the ideal. These tests were made on toughened steel wire and on $^5/_8$-in. 6 × 19 Warrington toughened steel elevator ropes incorporating the single wire as the large wire in the outer series.

When subject to bending, a wire rope behaves somewhere between a solid bar of the same outside dimensions and a loose assembly of wires, each acting independently. The degree of friction between the various components is constantly changing during the life of the rope, and with this variation, the stresses imposed on the wires. In an ordinary rope, the wires in the strand and the strands in the rope are simply sprung into position and held in place by a wrapping at the ends. Both wires and strands are under a continual stress. This may be best seen by cutting a seizing. In preformed rope the components are formed to the shape of the helix they will assume in the finished rope. There is therefore a minimum of internal stress and the strands stay in position relative to the core when the seizing is cut.

A stress analysis which does not take changing conditions and the presence or absence of internal stress into account fails of accurate prediction. Diligent testing and design, accurate manufacture, and intelligent application and use in the field are the answer to economic rope life. (A. V. DeForest, American Cable Company, Bridgeport, Conn., and L. W. Hopkins, Page Steel and Wire Company, Bridgeport, Conn., in a paper before the American Society for Testing Materials, Atlantic City, N. J., June, 1932, no. 43, 15 pp., 13 figs., abstracted from preprint, *ed*)

The Viscosity of Water

AN INVESTIGATION of this subject is included in the research program of the Bureau of Standards, and it is stated that in making the new determination of the viscosity of water, a method will be employed which is in a sense the direct opposite of that used in practically all previous determinations. It has been customary to cause a given volume of liquid to flow through a capillary orifice under a known pressure and to note the time required for its efflux. By the new method, the liquid will be caused to flow through the capillary at a known rate, and the difference between the pressures at the inlet to and the outlet from the capillary will be measured.

Viscosities are generally regarded as inversely proportional to the rates of flow of fluids through standard orifices under a standard head, or directly proportional to the time required for a certain quantity to flow through the orifice. This assumption is based on the law of streamline flow in capillaries. One of the factors in the equation for rate of flow through capillary passages is the length of the passage, or, rather, the length over which streamline flow continues. Now, it is obvious that there is no abrupt change from streamline to turbulent flow at the exit from the capillary passage, nor the reverse change exactly at the entrance to the passage. This deviation from theoretical conditions is taken care of by making an allowance for an "end effect." Unfortunately, the matter is complicated by the fact that this "end effect" is not constant for a capillary passage of given design, but varies with the viscosity of the liquid.

Owing to the existence of this end effect, viscosities are not absolutely proportional to the times of efflux of a given quantity under a definite head, and a correction factor must be applied to the results of observation. Variations from direct proportionality naturally are greatest if liquids are compared whose viscosities are widely different, and to minimize errors in such comparisons it is now proposed to establish a number of intermediate standards in addition to the water standard.

Importance is lent to the fundamental work on viscosity measurements by the recent discovery that frictional losses in journal bearings are dependent upon the viscosity of the lubricant throughout the whole range of lubricating conditions. While in the region of complete-film lubrication the frictional losses increase with the viscosity, in the region of thin-film lubrication frictional loss and viscosity of lubricant are inversely proportional.

It has been found that a journal type of friction machine is not well adapted for investigations in the region of thin-film lubrication, and for this reason a modification of the Herschell flat-plate friction machine has been adopted, by means of which it is planned to explore the entire region extending from the minimum point of the "friction coefficient vs. (viscosity × speed of revolution/unit pressure)" curve to the point of static friction.

It seems rather surprising at first glance that in the region of thin-film lubrication the coefficient of friction decreases as the viscosity of the oil increases, but on further consideration the reason for this becomes plain, because in this region there is a certain intermeshing of asperities on the surfaces of the journal and the bearing, and for the same values of rotative speed and load, this intermeshing—which is the cause of additional friction—is evidently less the higher the viscosity of the lubricant. (*Automotive Industries*, vol. 67, no. 10, Sept. 3, 1932, pp. 298-299, illustrated, *d*)

Band Method for Making Visible the Flow of Warm Air

THESE tests were carried out at the Engineering Experiment Station of the German Institute of Manual Crafts in Karlsruhe, and are said to provide a material contribution toward the investigation of the complicated processes of flow of warm air. In these tests it was found that bands were visible even with a temperature difference of 10 C (18 F), and it was found that in the majority of cases the results obtained on test models could be directly applied to practical engineering work. The first series of tests were carried out on a model of a smokestack provided with means to introduce side streams of cold and warm air and also with means to observe the effect of variation of cross-section of the stack. The model tests also permitted investigating the influence of inclining the smokestack axis.

The author believes that the band method is particularly adaptable for investigating the movement of warm air in a heated room. Tests made on a model and in a room of normal size appear to indicate that the flow of air occurs in the same way in both. The article presents band projections of gas and coal ovens which clearly indicate that the convection flow of heat takes place, first, around the heating body, and then lengthwise thereof. The abstract does not give any information as to how the band method is applied in this case. (Original article by Walter Bucerius in *Betriebsfuhrung*, Betriebswirtschaftliche Mitteilungen d. deut. Handwerkinstituts, vol. 11, 1932, no. 18, pp. 33-41, abstracted by Clodius in *Gas und Wasserfach*, vol. 75, no. 16, Apr. 16, 1932, p. 301, *p*)

SYNOPSES OF A.S.M.E. PAPERS

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APPLIED MECHANICS

Calculation of the Stresses Occurring in a Building During Earthquakes

MOTION of a building affected by an earthquake has the character of a transient oscillation. A general method of analysis of such an oscillation is developed and applied. The principles involved are the same as developed by Heaviside for the analysis of transient electric currents. Only the shearing deformations are considered in the paper. The calculation is carried out completely for a building of constant mass and rigidity at every floor except the first. The influence of an "elastic first floor" is investigated, and it is shown that the oscillation depends fundamentally on a parameter that is a product of a number of upper floors and the ratio of the rigidity of the first floor to that of the others. The solution of the problem for a sudden constant acceleration leads to a simple calculation of the effect of resonance. For the purpose of applying the theory to actual earthquake accelerations, a general theorem for elastic systems is established which gives a very simple method of calculating the oscillation amplitudes under a random impulse by considering its spectrum. A practical method is given to calculate the motion of any type of building. (Mimeographed paper, by Dr. M. Biot.)

On the Buckling Strength of Beams Under Axial Compression, Bridging Elastic Intermediate Supports

BUCKLING of beams under axial compression with intermediate supports subdividing the span is usually treated as though the supports were perfectly rigid—that is, permitting no deflection, only an inclination at the support station. The underlying idea is that for any load exceeding the mere Euler load of the unsupported entire span, but not exceeding the Euler load of the largest intermediate bay, the beam is in a state of equilibrium, unstable though it may be, so that virtually very small restoring forces are required at the intermediate support station to efficiently brace the beam until multiple-bay failure would be reached. On the other hand, it is quite evident that this cannot be a true picture of what happens, because if the intermediate supports were very "weak" (their "stiffness" thought of as approaching a zero limit), the number of such imaginary supports must become of negligible influence upon the strength of the beam. The paper considers the question of exactly how "stiff" an intermediate support must be in order to develop the full strength of the beam stipulated by the buckling theory of subdividing bays. If the stiffness of the supports were less, what would then be the actual strength of the beam, and what type of collapse would occur upon loading it to this limit? This question was actually raised by a problem of rigid-airship structure. The resulting tests yielded valuable information in constructing the *Akron*, and may be similarly advantageous in problems of bridges and tall buildings. (Mimeographed paper, by W. D. Klemperer and H. B. Gibbons.)

Two Solutions of the Problem of Plane Strain for a Beam Bent by Its Own Weight

SAINT-VENANT'S solution for the bending of a prismatical cantilever loaded at the end showed that the elementary theory of bending, based on the assumption that during bending the cross-sections of the cantilever remain plane, gives accurate values for normal stresses acting on the cross-sections. The differential equation for the deflection curve is also accurate—that is, the curvature of the center line of a cantilever deflected in one of the two principal planes is proportional at each cross-section to the corresponding value of the bending moment. If instead of a load at the end there is a distributed load, such as the weight of the beam, the elementary solutions for the longitudinal normal stresses and for the curvature of the center line do not coincide longer with the exact solutions, but the difference between the two solutions is practically negligible. The paper gives exact solutions for the bending of a cantilever under the action of its own weight for the cases of an elliptical cross-section and for a circular hollow cross-section. These solutions indicate that the elementary solutions for longitudinal normal stresses and for curvature are accurate enough in these cases also. (Mimeographed paper, by Prof. J. M. Klitchieff.)

Some Changes of Shape Characteristics of a Smooth, a Corrugated, and a Creased Pipe Bend Under Load

MEASUREMENTS made to determine the change in shape of the cross-sections of a smooth pipe bend, a corrugated pipe bend, and a creased pipe bend are described in this paper. It also shows the manner in which the plane of each corrugation of a corrugated bend rotates with reference to the one adjacent. This latter condition is true with the creased bend, but to a lesser degree. The three types of bend show distinct deformation characteristics when load is applied. The smooth bend shows a large change in the length of the two axes of the section. In the corrugated bend the change in the length of the axes is relatively small, although uniform throughout the bent portion. The change in tangential length, an increase on the outside of the bend and a decrease on the inside, is the deflection that gives this kind of bend its great flexibility. There does not seem to be a simple analytical method for evaluating the effect of the relative movement of the planes of the corrugations. These tests establish the fact of this movement and, for the bend tested, give the slopes of the curves showing change of tangential length with load. The creased bend seems to partake of the nature of both the smooth bend and the corrugated bend. The change of lengths of

axes is relatively larger than was found for the corrugated bend. The change in tangential lengths between the creases is of the same order as was found for the corrugated bend. (Mimeographed paper, by E. T. Cope and E. A. Wert.)

Shearing Stresses in Torsion and Bending by Membrane Analogy

SHEARING stresses in bars subjected to torsion and bending as solved by Saint-Venant's mathematical method have been applied successfully in only a few of those special cases where the boundary line of the cross-section was comparatively simple. Using his method as a basis, it can be proved that both torsion and bending problems can be solved by using soap films, as proposed by L. Prandtl. The paper describes the equipment developed for making soap-film tests and gives several results obtained. In the case of torsion, one simple problem is given in order to describe the method of establishing the degree of precision of the soap-film procedure. The problem of twist for angles having various fillet radii is developed, and the stress curve is given. In the case of bending, the circular, rectangular, and I-beam sections are chosen for soap-film analysis. The circular and rectangular results agree well with the Saint-Venant theory. The I-beam results show stresses of the same character as indicated by elementary theory. (Mimeographed paper, by P. Allerton Cushman.)

Vector Analysis of Sustained Vibrations of a System With Two Degrees of Freedom

IN THIS paper a vibratory system with two degrees of freedom is considered as a combination of two systems, each having one degree of freedom. The vector diagram is constructed for the one of the component systems on which no impressed force is acting. From this diagram the reaction upon the other system is determined. The vector diagram for the other system is then laid out with the reaction considered as another impressed force in addition to the given one. It is shown that under certain conditions charts can be constructed from which the vector diagram can be found directly, without calculation or construction. It requires only a few operations to plot from a chart of this kind the resonance curves for a system with given masses, elasticities, and damping characteristics. An example of the application of the charts is given. It is shown how to determine the proportions of a dynamic vibration absorber in order to make the absorber reduce the vibrations of a structure as efficiently as possible. (Mimeographed paper, by J. L. Mansa.)

The Distribution of Stress Due to a Single Force Acting at a Point on the Edge of a Circular Hole in an Infinite Plate

IN THIS paper the author undertakes, first, to find the stress distribution due to a concentrated force acting at a point on the boundary of a circular hole in a thin infinite plate; second, to give a method for finding the maximum stress for cases in which the load is not concentrated at a point; third, by applying the previous results to obtain approximately the stress distribution in the case of an infinite plate that contains two holes some distance apart, loaded by two concentrated forces acting on diametrically opposite points on the circumference of the two holes; and fourth, to describe some photo-elastic tests made to verify the mathematical solution. This problem was suggested by Dr. Nadai, and arose in connection with an attempt to determine in a more precise way the assembly stresses in the V-notch of a commutator bar. (Mimeographed paper, by W. O. Richmond.)

Vibration With (Velocity)^2 Damping

COMPARISON is made of the several approximations for the solution of the case of free vibration under (velocity)^2 damping with the exact solution as given by von Mises. This shows that whereas the decay curve for Coulomb damping is a straight line, and for straight velocity damping, an exponential, that for $\dot{x}^2$ damping, the decay is even more rapid at the beginning, and is approximated by a hyperbola. Of the several approximations, preference is held for the one developed by the author in 1929, because the same ideas may be extended to the case of forced vibrations. This has been done in the paper, and checked with results obtained by Jacobsen in 1930 by essentially the same reasoning. The object has been to bring the entire problem to as accurate a status as possible at the present time. (Mimeographed paper, by M. Stone.)

Stresses in Long Rectangular Plates With Uniform Lateral Loading

STRESSES and deflections in long rectangular plates, initially flat, supported at the edges, and subjected to a uniformly distributed load normal to the surface, are dealt with by the author. A typical example of such a plate would be a bottom plate on a ship. This problem would be quite simple if the edges of the plate were free to approach each other as deflection occurred. In practice this is seldom the case, the plate usually being attached to an elastic structure. Such a method of support sets up tensile reactions along the edges as soon as deflection takes place, and the tensile reactions depend upon the deflection. A solution that might be called exact is due to I. Boobnoff. The paper makes the practical results of the theoretical work already done on this problem available to engineers. Exact and approximate solutions are given. Curves have been plotted for finding the tensile reactions in terms of the plate constants and load, as well as certain useful functions of these reactions. (Mimeographed paper, by Stewart Way.)

MACHINE-SHOP PRACTICE

Some Developments in the Design and Applications of Gearing

TAKING the view that the treatment of gear-design problems has been unnecessarily subdivided and thus made incoherent and complicated, the endeavor has been to reduce it to a few simple principles of general application in order to secure a better general understanding of fundamentals, easier comparison and correlation of past and present practice and the work of independent research, and substitution of rational for some of the empirical design methods widely current, without sacrifice of simplicity. These principles are outlined, the unified methods of design which have been evolved and put into practice are described, and a few examples of the gear practice of the author's company are illustrated. (Mimeographed paper, by Henry R. Merritt.)

OIL AND GAS POWER

Fuel Injection in Gas Engines

DEVELOPMENT of the gas-injection engine is traced, with the process of selective improvement of mechanisms that gave the best results. The authors describe tests that were conducted to compare the gas consumption and the general heat balance of a four-cycle and a two-cycle engine with and without gas injection. (Mimeographed paper, by E. G. Beardsley and J. M. MacKendrick, Jr.)

STANDARDIZATION—CODIFICATION

Notes on Work of Technical Committees of the A.S.M.E., Etc.

Standardization

Standardization of Cast-Iron Soil Pipe and Fittings

THE standardization of cast-iron soil pipe and fittings was actively undertaken by industry in January, 1931, with the American Society of Sanitary Engineering and The American Society of Mechanical Engineers as joint sponsors under the procedure of the American Standards Association. The task of developing the first tentative proposal was assigned to Subcommittee No. 8 of the Sectional Committee on Standardization of Plumbing Equipment, Joseph J. Crotty, Chairman, which held its first meeting in that same month to outline its course of action.

The work of this committee has received the full cooperation of the manufacturers of soil pipe. Its personnel is as follows: J. J. Crotty, Chairman, F. R. McCarron, Secretary, C. A. Hamilton, A. Hansen, J. D. Johnson, W. J. Kirby, L. F. Moore, F. H. Morehead, and T. H. Powers.

At its organization meeting the work of developing this American Standard was divided into three main subdivisions: (1) nomenclature, (2) materials, marking, and inspection, and (3) dimensions and weights. Since then the Committee has held twelve meetings and the development of the standard has progressed steadily. A standard nomenclature has been completed, consisting of terms and names of the component parts of soil pipe and fittings, which it is proposed to recommend. These will tend to eliminate the confusion existing at the present time where different terms are used to denote the same item. The work on materials, markings, and inspection has resulted in the development of a simplified specification compared with that now in use, which is nevertheless more rigid in the essential features, and will therefore be better suited to meet the more exacting requirements of present-day practice. The third subdivision, that of dimensional standards and unified weights for soil pipe and fittings, is necessarily of prime importance, and with the exception of a very few items is ready for final approval by the Subcommittee membership and distribution to industry at large for review and comment.

In arriving at a series of standard dimensions for soil pipe and fittings, the task was divided into four parts: (*a*) Soil Pipe, Sizes 2 in. to 6 in., (*b*) Soil Pipe, Sizes 8 in. to 15 in., (*c*) Soil-Pipe Fittings, Sizes 2 in. to 6 in., and (*d*) Soil-Pipe Fittings, Sizes 8 in. to 15 in. Each of these parts presented a separate problem.

SOIL PIPE—SIZES 2 IN. TO 6 IN.

The specifications for cast-iron soil pipe and fittings known by the trade as "Naco" and published in 1915 were used as a starting point, and the data taken from it were checked carefully for the purpose of correcting certain inaccuracies discovered as a result of the study made by the members of Subcommittee No. 8.

The weights for 2-in. to 6-in. soil pipe as shown in that specification were found not to agree with the dimensions. As a result, the inside diameters of present pipe are less than those of the fittings. This is a justifiable ground for criticism which the industry has recognized for a long time. The Committee will therefore recommend that the weights of the pipe be reduced slightly in order that the pipe and fittings will carry the same inside diameters.

The proposed standard dimensions and weights for 2-in. to 6-in. soil pipe are shown in the following table:

Size (in.)	Outside diameter (in.)	Approximate wall thickness (in.)	Weight per 5-ft length (lb)
2	$2\frac{3}{8}$	$\frac{3}{16}$	25
3	$3\frac{1}{2}$	$\frac{1}{4}$	45
4	$4\frac{1}{2}$	$\frac{1}{4}$	60
5	$5\frac{1}{2}$	$\frac{1}{4}$	75
6	$6\frac{1}{2}$	$\frac{1}{4}$	95

SOIL PIPE—SIZES 8 IN. TO 15 IN.

Since no standard specification exists for soil pipe 8 in. to 15 in. in diameter it has taken considerable time and study to establish a standard which will adequately meet the requirements of the service for which it is intended and which, at the same time, will be in conformity with the standards proposed for the smaller sizes. The necessity of providing for the assembly of pipe and fittings as made at present by the various manufacturers with the new proposed standard had also to be considered.

The Committee is of the opinion that in proposing the following dimensions and weights for 8-in. to 15-in. soil pipe all of the foregoing factors have been given due consideration.

Size (in.)	Outside diameter (in.)	Approximate wall thickness (in.)	Weight per 5-ft length (lb)
8	$8\frac{5}{8}$	$\frac{5}{16}$	150
10	$10\frac{11}{16}$	$\frac{11}{32}$	215
12	$12\frac{3}{4}$	$\frac{3}{8}$	275
15	$15\frac{7}{8}$	$\frac{7}{16}$	375

SOIL PIPE FITTINGS—SIZES 2 IN. TO 15 IN.

The Committee has spent much time and given intensive study to the simplification of the list of approved fittings. Its report will include the following items for sizes 2 in. to 6 in. and a corresponding list for sizes 8 in. to 15 in.: $\frac{1}{4}$, $\frac{1}{5}$, $\frac{1}{6}$, $\frac{1}{8}$, and $\frac{1}{16}$ bends, return bends, long and short sweep $\frac{1}{4}$ bends, double $\frac{1}{4}$ bends, double spigot and low heel inlet $\frac{1}{4}$ bends, long $\frac{1}{4}$ bends and long $\frac{1}{8}$ bends, single, double, and long Y branches, combination Y and $\frac{1}{8}$ bends single and double, inverted single and double and upright Y branches, T and tapped T branches (approved for venting and cleanout purposes only), sanitary single and double and tapped T branches, long sanitary T branches, vent branches, reducers, increasers, long increasers, double hubs, plain and hub vented running traps, plain and hub vented $\frac{1}{2}$ and $\frac{3}{4}$ s. traps, s. traps plain and hub vented, traps with cleanout tapping, $\frac{1}{8}$ bend offset, extension pieces, T and Y cleanout brass trap screw on branch, Y cleanout with brass trap screw on main, combination Y and $\frac{1}{8}$ bend cleanout w/brass trap screw on main, pipe plugs, iron body ferrules.

This list of fittings for sizes 2 in. to 6 in. now includes 41 separate and distinct items, and the list for sizes 8 in. to 15 in. includes 19 items. It has been the aim of the Committee to

reduce the number of fittings to a minimum consistent with demands of the trade and yet maintain a sufficient variety of fittings to meet the requirements most efficiently. As a result the Committee has eliminated from its proposal 36 items or approximately 38 per cent of all the items at present manufactured. The fittings eliminated are those now obsolete or inconsistent with sanitary practice.

In the near future the Subcommittee expects to release this proposed American Standard for Cast-Iron Soil Pipe and Fittings for distribution to industry for comment. After such revisions as may seem advisable in light of the replies received have been made, it will be submitted to the Sectional Committee and to the sponsor societies for approval and then transmitted to the American Standards Association for approval and designation as an American Standard. Those desiring copies of this proposal are invited to write to C. B. LePage, Assistant Secretary, A.S.M.E., 29 West 39th Street, New York, N. Y.

A.S.M.E. Boiler Code

Case Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval, after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Below are given records of the interpretation of the Committee in Cases Nos. 706, 714, 725, 729, and 731, as formulated at meeting of September 16, 1932, all having been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

CASE NO. 706

Inquiry: Would a boiler drum fabricated of steel tubing purchased abroad which meets Code Specifications S-17 or S-18 be acceptable under the Code requirements?

Reply: It is the opinion of the Committee that steel tubing purchased abroad should be acceptable by boiler inspectors for the purpose specified provided it conforms to all the requirements of Specifications S-17 or S-18 and the provisions of Par. P-3.

CASE NO. 714 (Annulled)

CASE NO. 725

Inquiry: Is not the use of a diameter of 48 in. in the second section of Par. U-31 inconsistent with the present reading of the first section of this paragraph, and should not the limit of $^1/_2$-in. plate be substituted for the 48-in. diameter?

Reply: It is the opinion of the Committee that it was the intention to eliminate limiting diameters in Pars. U-30 and U-31 when the change was made from previous editions of the Code, and that the omission to change the "48 in. in diameter" in the second section of Par. U-31 was an oversight and there should be substituted therefor the words "$^1/_2$ in. in thickness."

CASE NO. 729

Inquiry: What is the definition of the term "lethal" as referred to in the Code for Unfired Pressure Vessels?

Reply: It is the opinion of the Committee that in this section of the Code the word "lethal" is to be interpreted as applying to poisonous gases or liquids of such a nature that a very small amount of the gas or vapor of the liquid mixed or unmixed with air when breathed is dangerous to life. For purposes of this Code, this class includes substances of this nature which are stored under pressure or may generate a pressure if stored in a closed vessel. Some such substances are hydrocyanic acid, carbonyl chloride, cyanogen, mustard gas, and xylyl bromide. For the purposes of this Code ammonia, chlorine, natural or manufactured gas, propane or butane are not considered as lethal substances, but it was the intention of the Committee that their storage should not be permitted in Class 3 pressure vessels.

CASE NO. 731

Inquiry: Is it permissible to attach by electric resistance butt welding, projecting metal elements to the shell or water-bearing portions of a power boiler for the purpose of forming extended heating surface, provided extensive tests have demonstrated that the effect of such resistance welds is scarcely noticeable as far as the physical properties of the shell are concerned? It is recognized that Par. P-186 imposes sharp limits on the area of welding that can be applied to a boiler shell, but attention is called to the fact that the electric resistance welding used in this case involves a minimum of heating of the plate.

Reply: It is the opinion of the Committee that the limitations imposed on the welding of non-pressure parts to power boiler shells or drums applies particularly to fusion welding and was not intended to apply to resistance welding where the entire area is welded simultaneously. The attachment of metal elements for extended heating surface by electric resistance butt welding does not conflict with the requirements of the code, and it is the opinion of the Committee that the electric resistance method of attaching projecting metal elements may be used under the conditions specified without reducing the maximum allowable working pressure.

Kmh System of Measuring Performance

(Continued from page 824)

This principle has had a partial application in three widely used mechanisms of industrial control: the Gantt chart, the budget, and standard costs. The Gantt chart plots requirements against actual performance for the same interval of time—a day, week, or month, as the case may be. For the period selected a rate is thus established. Budgets estimate expenditures for a year, for example, and divide the estimated amounts into weekly or monthly subdivisions. For each such subdivision a rate of expenditure is thus set up. Standard costs compare the actual costs with predetermined standards which in essence are rates for the input of labor and material costs and burden charges in the production of a particular article or commodity.

The kmh system is more direct in its application of the Law of Operating Rates, for it determines what has been done and what should be done in terms of rates such as have already been listed and described.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Department of "Mechanical Engineering" are solicited. Contributions particularly welcomed at all times are discussions of papers published in this journal, brief articles of current interest to mechanical engineers, or comments from members of The American Society of Mechanical Engineers on its activities or policies in Research and Standardization.

The Economics of Machine Production

TO THE EDITOR:

Mr. Flanders' article in the September issue on "The Economics of Machine Production" brings out very clearly the far-reaching social effects of the evils of excessive fixed expense. Doubtless with the increasing relative importance of fixed expense as an item in total cost, there will be an increasing instability in profits, output, and prices. Consequently anything that can be done to render fixed expense a smaller proportion of total cost will prove of benefit to the social structure as a whole as well as of direct material benefit to the individual plant.

In times of prosperity our industrial leaders have proved in general to be entirely too eager to rush into expansion programs which result in large increases in fixed expense. So long as high sales volumes are maintained, the effect of the increased cost is only reflected, if at all, in a decreased margin of profit. But when production is radically curtailed, the fixed portion of cost looms so large on the managerial horizon as to overshadow all other elements. The interest recently aroused in tax reduction is but one outward manifestation of the present efforts of managements to reduce a hitherto neglected item of cost.

Many plant managers do not seem to have a true appreciation of the basic fact that unit fixed cost times production equals a constant, a plot of the curve being hyperbolic in nature. As production falls, unit fixed expense inexorably increases, at first apparently slowly, but as the lower levels of production volume are reached each small absolute decrease in volume multiplies unit fixed expense at an alarming rate. When this stage is reached frenzied efforts are usually made to bring in new business to increase volume. The effects of this on price are brought out by Mr. Flanders.

Those engineers who have had an opportunity to visit a considerable number of industrial plants will probably agree with the statement that in most of them there is much more floor space and total machinery than is needed to produce goods to supply sales demands of even a 1929 peak volume. Certain machines, certain departments, may be loaded to capacity, but side by side with these efficiently operating units there will almost always be found machines and floor space which, if properly utilized, would be sufficient (as is frequently the case) for a dozen such plants.

If our business leaders can be brought to a realization of the fact that there are unlimited opportunities in virtually every plant for greatly increasing its capacity without a proportionate increase in fixed expense, it may be that in the future at least this one of the evils Mr. Flanders has described will be avoided or in some degree mitigated.

S. A. WEART.[1]

Boston, Mass.

[1] MacDonald Brothers, Inc. Assoc-Mem. A.S.M.E.

Will Economic Stability Suffice?

TO THE EDITOR:

I wish to express my appreciation of the many excellent articles dealing with the economics of society which have been published in MECHANICAL ENGINEERING during the past year. That these articles have been timely and helpful is evident from several letters that have been printed in the section devoted to correspondence.

The present economic crisis is so violent that many persons have suffered who never before knew the meaning of real want. Those who have always been wealthy, and those who have always been very poor, are apt to feel that conditions should not, or cannot, be changed; but persons who have suddenly been plunged from comfort into privation are much more likely to feel that conditions *must* be changed.

It is perhaps fortunate for society as a whole that engineers as a class have suffered even more than other professional groups. Engineers are, by nature and training, seekers after truth. Their method is to assemble the facts and then to draw logical conclusions from them. Furthermore, engineers occupy an intermediate position between those traditional rivals, capital and labor, and realize more clearly than either that cooperation is not merely a noble sentiment but is an economic necessity. They also know that both capital and labor have been responsible for much senseless warfare in the past. If suffering has really made us willing to think about the problems of society, then we may face the future with confidence, for when engineers *think*, action is sure to follow.

Many engineers have been surprised and disappointed to find that society, instead of feeling thankful for the many great inventions which have increased the productivity of capital and labor, is actually exhibiting a feeling of resentment. Perhaps resentment is justified. Perhaps we are morally responsible, as we would be were we to build boilers without safety valves, or steam turbines without governors, or speedy automobiles without brakes.

Let us learn the answers to the list of questions proposed by Mr. Mitereff in the August issue (p. 588) as a test for all men of affairs. These questions show that he has made a shrewd analysis of our troubles. Perhaps he can be induced to expand his analysis for our benefit.

The plan for promoting economic stability proposed by A. E. Kittredge in the same issue (p. 588) seems at first glance to be too simple, too easy, to have any real effect in dealing with such a complex problem. But is this really the case? Are not all really good inventions as simple as possible?

The basic principle of business is: "Buy low and sell high." Competition for customers sets the selling price, while competition for workers sets the wage level. Since workers are also customers, eventually the price level for all commodities used by workers is determined by the wage level. It is the large time element involved which produces the instability.

As I understand Mr. Kittredge's plan, he eliminates a large part of the time element ordinarily involved in the cycle of exchange, by enabling the competition for customers to adjust both the selling price and the wage level at the time the goods are sold. This constant correction of slight inequalities would keep buying power equal to producing power, and would thus produce business stability.

J. C. Lincoln's letter in the September issue dealing with "The Economics of Ground Rent," is a very clear statement of a problem on which economists are strangely silent. It is the basic cause, not only of the recurrent business cycle, but of the fact that increasing national wealth produces increasing want and insecurity for all but a small proportion of our people. It explains the resentment of society as a whole toward engineers, inventors, and scientists. It explains why increased efficiency and productivity in agriculture, mining, manufacturing, and trading fail to raise the standard of living proportionately. It is the "Law of Ground Rent."

Mr. Lincoln says we may consider his proposal that taxes should be derived principally from ground rent, as very radical. In view of the facts, I should say that any other basis, though established centuries ago, is unjust to society.

In conclusion I wish to leave this thought: Should we merely seek to promote economic stability as long as progress is largely absorbed by rent? Can we be satisfied to have our work nullified in this manner? Just because this problem is of long standing, is it safe to ignore it forever?

O. N. BRYANT.[2]

The Transportation Dilemma

TO THE EDITOR:

One of the most commendable services which MECHANICAL ENGINEERING renders is that of broadening the viewpoint of the engineer by keeping him informed of the economic and social aspects of his profession, and preventing him by such continuous educational effort from losing himself in purely mechanical or scientific problems.

But to the writer, an engineer who by regular reading of its pages has formed and strengthened this impression of the journal's value, the leading article, on "The Transportation Dilemma" in the August issue comes as a profound shock. That article, at its best, is an extreme example of technical one-sidedness, evidencing as it does an utter lack of economic thinking and of contact with life. Basic commercial considerations are disposed of by superficial remarks, a scheme contemplating the expenditure of a dozen or more billions is treated as if it involved merely a modest outlay for experimental work, and, apparently in a vein of irony, the author ventures to discuss the valuation of railway securities. Worse than this, however, even in its purely technical features the presentation is completely lacking in that evidence of basic study without which a proposition of such far-reaching scope cannot be taken seriously. It is a presentation of a character which MECHANICAL ENGINEERING has usually been very careful to avoid, and one is immediately reminded of the Editor's closing remarks in his comment upon the subject: "It is something to ponder over; maybe you can think of a better scheme." Indeed, this remains the only consolation.

A. GIESL-GIESLINGEN.[3]

New York, N. Y.

[2] Diesel Development Engineer, Westinghouse Elec. & Mfg. Co., Philadelphia, Pa. Mem. A.S.M.E.

[3] 53 Washington Square.

What Is It All About?

TO THE EDITOR:

If "Patriotism is the last refuge of a scoundrel," criticism may be the first defense of incompetence! . . . and that may be why I offer a few thoughts regarding the very interesting editorial in the September number of MECHANICAL ENGINEERING and also Mr. Seibert's and Mr. Hirshfeld's papers. Really, I hesitate to say anything; while a member for more than thirty years, my active interest has been confined to sending a belated check for annual dues, but perhaps one reason is because I am less interested in technical engineering than in "What it's all about!"

Now, what *is* it all about? Three thousand years ago a Wise Man remarked that "In much wisdom is much grief, and he that increaseth knowledge, increaseth sorrow." From all reports the aphorism is just as true now as thirty centuries ago. While hailed as a builder, I never knew that Solomon was much of an engineer, but he, or some one, knew the human spirit well enough to work out a whole philosophy of life for the Jew—expressed in a few pithy maxims or slogans that have survived a lot of wear and tear. Engineers deal with wear and tear, but unluckily, not with the spiritual kind, and just because they do not and because more than sixty years of life have convinced me that man *is* a "spiritual" animal—meaning by that, a more or less self-determined, unpredictable being, never satisfied by conquest and full of longings, regrets, ambitions, and fears—I make bold to question the engineer's ability to "banish" any "cloud forever," arising out of man's endless hunt for satisfactions.

Psychoanalysis seems to have demonstrated that practically every one is motivated from within out of the subconscious, and while reason and logic guide all technical operations in which men engage, they obliterate no fears, subdue no longings, stifle no regrets, and moderate few ambitions. Reason and logic seem to be intellectual tools, like hands or crowbars, but I have survived several major panics and depressions without observing that in the day of prosperity reason would induce men to stop speculating or that in adversity it would cause them to buy bargains. More than ever, by the very processes of democracy, we have entered upon a mass age, and in a sense, especially in the United States, what one does, all do—and at the same time. Man's spirit "bloweth where it listeth," and this is something the engineer seems inherently not qualified to deal with. Obviously he could become qualified to guide it, but only on the basis of some philosophy of life, some "religion," even as the Bolshevik has his own, as the Jew has his, the Hindoo his, the Mohammedan his, and the Puritan had another.

Now just what "religion," what master-principle of life to be used to orient all human technical work, does the engineer glory in today? Unluckily, most of us are perhaps like Erasmus, who encouraged Luther because he expressed Truth, but remained with the Pope because European life as it stood ministered so well to his esthetic urges. To be frank, we have in general no philosophy of life except a subconscious Christianity so badly damaged in its dogmatic forms that it is unable to motivate anything more than an uneasy conscience when our increased wisdom has piled up the social griefs of others.

Often I have ventured the statement to people that the day of the lawyer-politician in control of political administrative affairs is slowly drawing to a close, and then I wonder just how much better qualified we engineers shall be to take his place! I sympathize with the general views of Seibert and Hirshfeld, but the engineer will not long be tolerated at the

helm unless he is able to energize great masses of human *spirits*. A new psychology and a profounder understanding are needed to cope with the changed psychic condition of the people. Most of the "meanings" understood by our ancestors who dealt with life have no great grip today, and just because they have not, we are adrift in every field of spiritual life—religion, economics, philosophy, and art. Here is where I disagree with the proposers of mechanized schemes of any sort as solvents of social disorders. Either man is just animal, in which case the Bolshevik plan to feed the brute and keep him contented is in order, or man is essentially a spiritual being and his spirit is his essence, so that food and drink and clothing even are very minor matters, in which case he needs spiritual goals such as Jesus, Buddha, or Mrs. Eddy postulated. The East looks upon life as a sad necessity and turns a jaundiced eye upon it. Gandhi proposes to starve himself for a cause. The West considers it a field for conquest and exhalts heroism and sacrifice only because both minister to our inner spiritual needs. If the engineer answers to this that such matters do not really concern him, that after all he deals with hard realities, things as they are, that men see, hear, and handle, I have only to say that in my view the engineer in such case had better act like the shoemaker—stick to his last, for essentially life is a tragedy.

However, the fact that as a profession we are inclined to repent our too exclusive emphasis upon material things is a good sign of a somewhat changed heart, and if any advisory bodies of any kind can function to bring necessary changes in engineering education, certainly I shall be glad. All I ever got at a technical school was technics; life taught me the rest, but the schools could ease the shocks! In any case Mr. Hoover's presence in the White House is a sign that more of us will be drawn into administrative political positions, and that soon; the lawyer has his philosophy . . . the precedents of a thousand years of Christian civilization. Science and engineering have undermined and exploded much of it as not applicable to this age, and the lawyer is confused even in his own house. We have built the machine, can supply the fuel and press the button—but "where do we go from here?" The world will not wait long to find out; if we have no answer, some "conductor" will cry "all aboard" for a definite goal, and an invisible dispatcher will set the signals; we'll just start and stop the engine, and rebuild and repair it—useful work, but not essential, for people *can* walk!

GEORGE I. KING.[4]

Brooklyn, N. Y.

Public Works and Recovery

TO THE EDITOR:

In the September issue of MECHANICAL ENGINEERING D. C. Coyle very clearly states the case for the theory of "timed" public works as an aid to the recovery of business from depressions. The scheme, however, suffers from the same vital defect that has prevented the adoption of many another sound proposal, namely, the necessity of securing the unanimous consent of the controlling interests before action can take place. When we consider the enormous inertia of the human mind, together with man's inherent fear that he may exchange the substance for a shadow, we can easily see why economic schemes depending upon mutual agreement and the surrender of vested interests remain utopias advocated chiefly by idealists and propertyless men.

Permanent changes in society are rarely accomplished by moral persuasion. Now and again a great prophet rises to inspire men to adopt new customs, or perhaps a powerful tyrant bends large masses of people to his will and forces them into a homogeneous whole; but such movements are rarely permanent, and once the unbalanced force is removed the mass of the people revert to their old habits of individual self-interest. A glance at the pages of history shows that permanent changes are brought about by new discoveries or inventions that yield tangible advantages to the individuals in control. The discovery of America had far-reaching consequences on the world's history that finally resulted in a different mode of living for every community in existence. However, it was not necessary for Columbus to convince either the members or the leaders of these communities of the advantages to be gained by future generations before action could take place. On the contrary, a few adventurous spirits saw that they could advance their personal fortunes by settling in the new country, and the rest of the world was enriched without any conscious effort on its part.

Another illustration is the first industrial revolution. The change from hand to machine technic could not have been made in the textile industry if the inventors of the new processes had had to sell their ideas to the whole mass of weavers and spinners before a step could be taken in the conversion. What actually happened was that a new process was offered that gave overwhelming advantages to the few who had the agility of mind to adopt it. The inert mass of the population, as well as the ruling caste, had no choice in the matter, but were forced by an irresistible tide to change their whole habits of life. Mankind as a whole gained enormously by the change, in that for the first time in history it became easy to produce valuable goods, but there was a corresponding decline in the value of an individual's labor. This is the root of our present-day troubles, and the remedy lies not in legislative action but in some counter-invention that will once more make man's labor a valuable possession. Trade unions try to do this artificially, but without success. Governments try to do the same with their factory acts and minimum-wage laws, but such palliatives are feeble in the extreme.

Consequently it seems to me that all schemes that put their trust in political action will remain subjects of discussion for debating teams. The first industrial revolution was a blind stampede in which the leaders were actuated by selfish motives. The second industrial revolution, marked by mass production and the use of electric power, was more intelligently directed, and the leaders were not unmindful of the interests of labor and the public. Is it too much to hope that with our growing accumulation of scientific knowledge and engineering skill we may be able to plan a third industrial revolution which will open up new fields of human labor?

I believe that certain forms of research work together with economic surveys and the pioneering of doubtful but promising engineering projects should be undertaken at the expense of the community for the benefit of the community. Whether this is done by the Government or by so-called private agencies is immaterial as long as it is properly done. But I fail to see how it would be of lasting benefit to the community if the all-too-small supply of capital money was drained away either by non-commercial public works or by the so-called dole.

CYRIL DONALDSON.[5]

Rochester, N. Y.

[4] Research Engineer in Financial, Industrial, and Commercial Problems. Subway Designer with Board of Transportation, New York City. Mem. A.S.M.E.

[5] Instructor, Rochester Athenaeum and Mechanics Institute. Mem. A.S.M.E.

BOOK REVIEWS AND LIBRARY NOTES

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Work, Wealth, and Happiness of Mankind

THE WORK, WEALTH, AND HAPPINESS OF MANKIND. By H. G. Wells. Doubleday, Doran & Co., Garden City, N. Y., 1931. Cloth, 6¼ × 9 in., 2 vol., 924 pp., illus., $7.50. One-volume edition, 866 pp., by William Heinemann, Ltd., London, 1932, 10s. 6d.

REVIEWED BY RICHARD E. KINSMAN[1]

THE last few years have made most of us realize that we can no longer confine our thoughts to our families, our pleasures, and the details of our particular jobs. Whatever our work may be, and however engrossing, we have come to realize that it is but one fragment of a huge mosaic, and since curiosity is a necessary characteristic of an engineer, we are all trying to get some idea of the large pattern of which our work is but a part.

None of us would by choice undertake to become familiar with a strange machine by going over the detailed drawings of the component parts; we should much prefer to start with the assembly drawings and then get down to the details. Yet most of the articles dealing with economic conditions, and which are so plentiful today, would be described either as minor assemblies or at best as only a side view. School textbooks on economics are useful, but they are primarily intended to be the backbones of courses of study. Very few of us would be willing to go back to such sources for the general information for which we are so eager. We want to know the principles of economics, but while we need a complete picture we do not want it to be dull, drab, and hard to keep our minds on. We all know that outside of production, with which we are familiar, health, recreation, social customs, public safety, public welfare, education, the force of public opinion as centered in the press, are important factors in the life of the community, but we do not know their relative importance nor fully appreciate how they function.

Last year, at a most opportune time, H. G. Wells brought out his two-volume work on "The Work, Wealth, and Happiness of Mankind." To read it through thoughtfully takes some 40 to 50 hours. When one has finished it he will realize how very complex is the problem of modern life, but he will have gained a knowledge of the relative importance of the various factors, and a very fair picture of the scheme of things which go to make up life as a whole. He will realize how many factors other than the application of science enter into the problems we face today, and how slowly the various factors change. One cannot help feeling that in the years to come, when our present difficulties have been solved, they will appear to our children to have been of a merely transitory kind.

Let Mr. Wells himself speak of the purpose of his book:

> This world of making and fetching and carrying and buying and selling to which you give the greater part of your waking life, is ruled by certain laws, obsessed by certain defects (which perhaps you may help to cure), and threatened by certain dangers you may help to avert. I am attempting for myself and you, a complete chart of economic life, not simply to help you to steer yourself through the confusion, but also to supply a common ground upon which we two can cooperate in this great experiment of life.

That this work was done by Mr. Wells is very fortunate from an engineer's viewpoint. Mr. Wells received his degree in science from the University of London, and taught science until he discovered his gift for writing. His viewpoint is that of a technically trained man, and his lines of reasoning are therefore clearer and the more easily followed. The work is obviously beyond the power of any one man, and credit has been frankly and fully given by the author where it is due.

Mr. Wells follows the time-tested method of first giving a clear and beautifully written summary of his problem and then, in succeeding chapters, filling in the details. After one has read the book the index of the chapter headings seems to be a remarkable outline of the whole work.

The American reader will at first feel that to some extent the author is too British in his point of view, but while most of us could add very interesting examples from our personal experiences, it will be realized on maturer reflection that Mr. Wells has taken a broad, world-wide view on nearly all questions. An author does better to illustrate his ideas with material of which he has personal knowledge. On the whole, he has been very fair to us, and it is our own fault if no such book has been produced dealing with world affairs from a primarily American point of view. Perhaps it is better so, for it has often been said that we take more kindly to having our weaknesses pointed out to us by some one not a native of this country.

The accuracy of the compilation of facts appears to be very high. There is room for argument on some of the conclusions drawn from the facts, but Mr. Wells would unquestionably be among the first to say that the science of economics, founded as it is to some extent on the play of human emotions, has far to go before it allows of unequivocal statements of what is right or wrong.

The work is published in a very pleasing way. The type is clear and of satisfactory size. Where charts are needed they have been well drawn. The reference index at the end of the book is sufficiently complete. Extremely good taste

[1] President and General Manager, F. W. Kinsman & Co., Elmira, N. Y. Mem. A.S.M.E.

was used in selecting the illustrations added to bring out the thought of the printed matter. It sometimes seems as though one picture can do more than a thousand words of reading matter to demonstrate an idea.

Sydney Harbor Bridge

SYDNEY HARBOUR BRIDGE. Reprinted from *The Engineer*. Morgan Brothers, Ltd., London, 1932. Pamphlet, 8½ × 11 in., 60 pp., 61 illus., 2s 6d.

REVIEWED BY OTIS E. HOVEY[2]

THE Sydney Harbor Bridge was opened to traffic on March 19, 1932. A notable engineering project, discussed for more than a hundred years, and under construction for eight years, is finished. It stands as a monument to the enterprise of New South Wales, and to the imagination, skill, and arduous labors of the officials, engineers, architects, and builders engaged on its design and construction.

The main structure is a massive two-hinged arch crossing the harbor in a single, graceful span of 1650 ft, a width of 160 ft, and rising to a height of 440 ft. It is one of the notable engineering structures of the world.

During March and April, 1932, a series of articles appeared in *The Engineer*, London, and they have been republished in convenient pamphlet form. Eight chapters give condensed but quite complete data concerning the history of the project and its personnel, also regarding materials, unit stresses, design, and fabrication and construction of the substructure and superstructure of the bridge and its approaches.

Many subjects are discussed which are of special interest and value to engineers engaged in bridge design and construction. Among them may be mentioned: the liberal use of silicon steel; the design of the arch trusses, bracing and floor; the enormous end bearings for the arches; the wire-rope anchorages, for the erection of the half-arches, which extended through inclined tunnels in the bed rock behind the skewbacks; the masonry substructure and pylons; the manufacture of the steelwork; the methods used in erecting and closing the half-arches; and the adjustment of the main trusses, closed as three-hinged arches, to act as two-hinged arches in the finished structure.

The pamphlet is profusely illustrated by excellent reproductions from line drawings and photographs.

Dynamics of Engine and Shaft

DYNAMICS OF ENGINE AND SHAFT. By Ralph E. Root. John Wiley & Sons, Inc., New York, 1932. Cloth, 6 × 9 in., 184 pp., illus., $3.00.

REVIEWED BY A. E. NORTON[3]

THIS book is a very brief exposition of a subject which for complete treatment would require many more than its 180-odd pages. It was written as a textbook for a special group, namely, student officers at the Post-graduate School of the U. S. Naval Academy.

Approximately half of the text deals with the accelerations and forces set up in the engine mechanism, the remainder being devoted to the effect on the elastic structure and the nature and cure of the resulting vibrations. In addition there are supplementary pages of engine data and problems for solution by the student.

The book requires of the reader not only a good background of fundamental mechanics, but also some previous experience in engine analysis if he is to keep his feet on the ground while following the mathematical equations.

The practical generalizations resulting from an inspection of these equations, while brief, are on the whole sound. One might question the analysis of power loss due to bearing friction in Chapter V where the quantity *pv* is used as an index of bearing performances without any reference to the hydrodynamic theory of lubrication.

The work is not confined to engines of the common "straight" type, but includes discussion of the V-type and of radial engines with articulated connecting rods. In treating the subject of vibrations and critical speed, the author avoids overemphasis on quantitative treatment of actual physical structures, and, properly, develops rational ideas for the correction of evils due to vibration in a few simple cases.

As in many books on this subject, the meaning of certain terms is taken for granted without adequate geometrical and physical definition; for example, "shaking forces," "rocking moments," "rolling moments." To define these terms adequately with specific geometrical statement of the line of action of all forces involved is half of the battle in making this intricate subject convincing. The lack of space devoted to this phase is, of course, explained by the brevity of the text and the presence of the author or teacher in the classroom to add his own words of explanation. Perhaps this is as good a method as can be devised for teaching this difficult subject.

The book is not meant to compete with the standard treatises on each of the subjects included, but when supplemented by such classical works will serve as a guide for graduate or advanced study by mechanical engineers, of which there has been too little in this country. The writing of such a brief book is one step in creating a more general interest in the problems of balance and vibration of reciprocating engines.

Books Received in the Library

ALFRED KRUPP. (Deutsches Museum Abhandlungen und Berichte, Jahrgang 4, Heft 4.) By W. Berdrow. V.D.I. Verlag, Berlin, 1932. Paper, 6 × 8 in., 130 pp., illus., 0.90 r.m. The official biographer of the great iron master has prepared this brief, popular account of Krupp's life, which will be useful to those who wish a concise yet accurate biography.

ATM ARCHIV FÜR TECHNISCHES MESSEN. Lieferungen 13–14, July-August, 1932. R. Oldenbourg, Munich and Berlin. Paper, 9 × 12 in., illus., diagrams, charts, tables, 1.50 r.m. each. These are sections of a comprehensive work on methods of technical measurement and measuring instruments, which is being published serially. Each number contains brief articles written by specialists and usually accompanied by bibliographies. The articles are punched for loose-leaf binders and classified so that they may be arranged for convenient reference.

DAUERFESTIGKEIT UND KONSTRUKTION. (Mitteilungen der Materialprüfungsanstalt an der Technischen Hochschule Darmstadt, Heft 1.) By A. Thum and W. Buchmann. V.D.I. Verlag, Berlin, 1932. Paper, 6 × 9 in., 81 pp., illus., diagrams, charts, tables, 6.90 r.m. Although nearly all fractures of machines are fatigue fractures, current theories of design are practically all based on the results of tests under static loads or unidirectional stresses. The present book is intended to obviate this difficulty by providing the designer with a clear idea of the conditions resulting from alternating stresses and of ways of meeting them. The results of experimentation are summarized in systematic fashion, and the fundamentals which must be considered in designing parts subject to such stresses are indicated. Rules for calculating these parts, for choosing materials, and for inspection are given.

DIE ABHÄNGIGKEIT DER WERKSTOFFDÄMPFUNG VON DER GRÖSSE UND GESCHWINDIGKEIT DER FORMÄNDERUNG. (Mitteilungen des Wöhler-Instituts, No. 11.) By E. Bankwitz. N.E.M. Verlag, Berlin, 1932.

[2] Consulting Engineer, American Bridge Company, New York, N. Y. Mem. A.S.M.E.

[3] Professor of Applied Mechanics, The Harvard Engineering School, Cambridge, Mass. Mem. A.S.M.E.

Paper, 6 × 8 in., 53 pp., illus., diagrams, charts, tables, 3.60 r.m. A contribution to our knowledge of the behavior of metals under repeated stress. Vibration diagrams of steel, copper, brass, and aluminum, based upon careful tests, are given, and the influence of speed of deformation upon the magnitude of damping, and of alternating stresses upon the static properties of these materials are discussed.

DIESELMOTOREN IN DER ELEKTRIZITÄTSWIRTSCHAFT INSBESONDERE FÜR SPITZENDECKUNG. By M. Gercke. Julius Springer, Berlin, 1932. Paper, 6 × 10 in., 92 pp., illus., diagrams, charts, tables, 6 r.m. A study of the suitability of Diesel engines for electric power plants and of the extent to which they have been used. The author gives data upon Diesel-driven plants throughout the world, discusses the advantages of Diesel engines as stand-by and peak-load equipment, and compares their economy to that of steam equipment.

EINFÜHRUNG IN DIE THEORETISCHE KINEMATIK. By R. Müller. Julius Springer, Berlin, 1932. Paper, 6 × 9 in., 124 pp., diagrams, tables, 6.80 r.m. This textbook presents the course given by the author at the Darmstadt Technical College. As indicated by the title, it is intended primarily for students of mechanical and electrical engineering, but it also is adapted to students of mathematics. The theoretical principles underlying machine design are presented, the method in general being a purely geometrical one.

ELEMENTS OF PHYSICS. By A. W. Smith. Third edition. McGraw-Hill Book Co., New York and London, 1932. Cloth, 6 × 9 in., 778 pp., illus., diagrams, charts, tables, 9 × 6 in., cloth, $3.50. This college textbook gives a survey of the field of physics with considerable emphasis upon modern physics. An endeavor is made to encourage the student to form physical images of the principles presented and to apply these principles to the explanation of everyday experiences. Applications of physics to agriculture, engineering, and everyday life are largely used to illustrate the principles.

ENCYCLOPAEDIA OF OXY-ACETYLENE WELDING. Two vols. Vol. 1. Pipe Construction. 83 pp. Vol. 2. Construction of Apparatus and Containers. 80 pp. International Advisory Committee for Carbide and Welding Technique, Geneva, Switzerland, 1932. (Gift of Acetylene and Welding Consulting Bureau, Ltd., London.) Cloth, 9 × 12 in., illus., diagrams, tables, 10s. 6d. These volumes are the first two of a series of six which are intended to form an album of the applications of oxyacetylene welding. Each volume contains about eighty plates of photographs of welded structures, with brief explanations in five languages. The photographs have been supplied by German and Swiss firms and illustrate the uses of welding in a large variety of structures: chimneys, gas mains, electric poles, heating coils, steam lines, fireboxes, stills, evaporators, and tanks and containers. The engineer or manufacturer will find the work interesting and suggestive of many uses for the process.

ERGEBNISSE DER AERODYNAMISCHEN VERSUCHSANSTALT ZU GÖTTINGEN. Lieferung 4. By L. Prandtl and A. Betz. R. Oldenbourg, Munich and Berlin, 1932. Cloth, 8 × 11 in., 148 pp., illus., diagrams, charts, tables, 11.80 r.m. The first section describes new equipment of the laboratory, including the new laboratory for testing propellers. In the second section Dr. Prandtl gives a theoretical discussion of turbulent flow in pipes and along plates. The third section gives the results of recent experimental investigations. These are chiefly connected with aviation, but include articles on wind pressure on closed and open buildings and on gas holders, investigations of car ventilators, and the resistance of cloth and wire screens.

DIE FAHRWIDERSTÄNDE DES ROLLMATERIALS IM BAUBETRIEB. (Mitteilungen des Forschungsinstituts für Maschinenwesen beim Baubetrieb, Heft 3.) By J. Engel. V.D.I. Verlag, Berlin, 1932. Paper, 8 × 12 in., 35 pp., illus., diagrams, charts, tables, 7.20 r.m. Presents the results of a theoretical and practical study of the effect of the rolling resistance of contractor's railway equipment upon the cost of moving earth in building operations. The effects of car construction, bearings, track gage, curve radius, and other items upon rolling resistance are determined, and methods for using the data in estimating and controlling the cost of the work are given.

FEILEN. (Werkstattbücher, Heft 46.) By B. Buxbaum. Julius Springer, Berlin, 1932. Paper, 6 × 9 in., 60 pp., illus., diagrams, charts, tables, 2 r.m. This small book discusses files from the point of view of the user. The varieties of files, standards, methods of manufacture, teeth, testing, and the use of files are described concisely and practically. The work is a useful addition to the scanty literature on files.

HANDBOOK OF THE NATIONAL DISTRICT HEATING ASSOCIATION. Second edition. National District Heating Association, Greenville, Ohio, 1932. Cloth, 6 × 9 in., 538 pp., illus., diagrams, charts, tables, $5. This handbook of district heating has been prepared by the Association as a manual of practice for those in the industry and a description of it for the general student. The growth and present status of district heating, the physical and engineering data ordinarily needed, methods of heating buildings, miscellaneous building equipment, steam distribution, district plants, metering, hot-water heating, corrosion, rates, selling, and the economical use of steam are discussed. The book is the work of a number of collaborators using material collected from the proceedings of the Association and the files of operating companies.

HARVARD BUSINESS REPORTS, Vol. 11, Cases on Cooperative Advertising. By N. P. Borden. Harvard University, Graduate School of Business Administration; McGraw-Hill Book Co., New York, 1932. Cloth, 6 × 9 in., 352 pp., illus., tables, $5. A number of cases of cooperative advertising efforts by trade associations are reported in this volume, including campaigns by manufacturers of paint and varnish, woodworking machinery, gas, portland cement, rubber, and silverware. The success of these efforts to stimulate trade is noted, and the possibilities and problems of this kind of advertising are discussed.

HEAT-TREATMENT AND ANNEALING OF ALUMINIUM AND ITS ALLOYS. By N. F. Budgen and D. Hanson. Chapman & Hall, Ltd., London, 1932. Cloth, 6 × 10 in., 341 pp., illus., diagrams, charts, tables, 25s. The theories of hardening and strengthening aluminum alloys, the practical methods of treating them thermally and the equipment required, the effects of thermal treatment upon the physical properties of wrought and cast material, and the annealing of wrought and cast aluminum and its alloys are discussed comprehensively in this book, the first on the subject. It brings together the information scattered through technical literature and presents it in form for practical use. Dr. Budgen is superintendent of a large English aluminum foundry.

DIE KREISELPUMPEN. By C. Pfleiderer. Second edition. J. Springer, Berlin, 1932. Cloth, 6 × 10 in., 454 pp., illus., diagrams, charts, tables, 29.50 r.m. Professor Pfleiderer has revised and enlarged this edition of his well-known work upon centrifugal pumps to include the latest results of hydrodynamic research and practice. His book affords a comprehensive review of theory and design, suited to the needs of practicing engineers.

NOMOGRAM—The Theory and Practical Construction of Computation Charts. By H. J. Allcock and J. R. Jones. Isaac Pitman & Sons, London & New York, 1932. Cloth, 6 × 9 in., 209 pp., diagrams, charts, tables, $3. Nomograms representing particular formulas are frequently published, and several books dealing with portions of the subject have appeared in English, but there has been, these authors say, no attempt at a systematic treatment of the subject from the practical as well as the theoretical point of view. This book is intended to supply the lack. The authors discuss the general theory of nomograms and also give practical directions for making and using all classes of computation charts which have scientific or industrial usefulness. The book covers the field very satisfactorily and will be welcomed by calculators.

SCIENTIFIC PRINCIPLES OF PETROLEUM TECHNOLOGY. By L. Gurwitsch and H. Moore. Second edition. D. Van Nostrand Co., New York, 1932. Cloth, 6 × 9 in., 572 pp., illus., diagrams, charts, tables, $8. In 1926 Mr. Moore published a translation, with additions, of Professor Gurwitsch's well-known book. This translation he has now revised and further extended, especially to include the results of recent American research work. The book discusses the chemistry and physics of petroleum and the methods of distilling and refining it, and of the principal products, from the scientific point of view, without attempting to treat practical questions of technology. As a review of petroleum chemistry, the book is a welcome addition to the literature.

SMOKE: A Study of Aerial Disperse Systems. By R. Whytlaw-Gray and H. S. Patterson. Edward Arnold & Co., London, 1932. Cloth, 6 × 9 in., 192 pp., illus., diagrams, charts, tables, 14 s. Although much attention has been directed to practical problems connected with smoke, few attempts have been made to explain the behavior of smoke in terms of general principles, or even to correlate its properties with the number, size, and nature of its constituent particles. The present volume is a contribution to the scientific study of smoke, based largely upon investigations carried out at Leeds during the last few years. It provides a general survey of the subject, describes the methods of investigation and the results obtained and points out lines for further research.

CURRENT MECHANICAL ENGINEERING LITERATURE

Selected References From The Engineering Index Service

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THE ENGINEERING INDEX SERVICE furnishes to its subscribers a Weekly Card Index of references to the periodical literature of the world covering every phase of engineering activity, including Aeronautic, Chemical, Civil, Electrical, Management, Mechanical, Mining and Metallurgical, Naval and Marine, Railway, etc. Of the many items of particular interest to mechanical engineers a few are selected for presentation each month in this section of "Mechanical Engineering." In operating The Engineering Index Service, The American Society of Mechanical Engineers makes available the information contained in the more than 1800 technical publications received by the Engineering Societies Library (New York), thus bringing the great resources of that library to the entire engineering profession. At the end of the year all references issued by the Service are published in book form, this annual volume being known as "The Engineering Index."

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AIR PREHEATERS

THERMAL BALANCE. Thermal Balance of Air Preheaters of Large Steam Generators, W. F. Harlow. Engineering v 134 n 3480 Sept 23 1923 p 356–7. Data on performance of air heaters at sea and in power stations; reference to investigations of M. W. Travers; design is such that if expected performance is not obtained, difficulties of correction are generally insuperable; it appears reasonable to design air heaters on ratio higher than ideal figure, say, 1.4 or 1.5, as safeguard against failure to obtain anticipated result.

AIRPLANES

AUTOGIROS. Das Drehfluegelflugzeug. M. Schrenk. VDI Zeit v 76 n 35 Aug 27 1932 p 843–6. Development, design, and performance of 3-blade autogiro built by Focke-Wulf-Flugzeugbau, A.-G., Bremen.

Le clinogyre Odier-Bessière. Aéronautique v 14 n 160 Sept 1932 p 274–6. Aerodynamic characteristics of Odier-Bessière clinogyre with 4-blade rotor turning at 400 rpm; advantages over Cierva autogiro.

GYROPLANES. See *Gyroplanes*.

PROPELLERS—DESIGN. Determination of Airscrew Design Conditions, J. D. Blyth. Flight v 24 n 1235 Aug 26 1932 (Aircraft Engr Supp) p 802a–802b. Means of estimating to close degree of accuracy rpm at top speed; numerical example shows that airscrew designed to give maximum efficiency at 2580 rpm at 150 mph will hold down to 2250 rpm on climb at 93 mph.

ALUMINUM ALLOYS

ALUMINUM BRONZE—CASTINGS. Aluminium Bronze in Foundry, W. Lambert. Metal Industry (Lond.) v 41 n 9 and 10 Aug 26 1932 p 195–6 and Sept 2 p 221–3. Conditions governing economic production of sound castings; compounding of alloy; molding and founding; iron or nickel prevents self-annealing; effects of certain additions; melting losses; compounding of aluminum bronzes; introducing alloying metals; precautions in skimming; cast-on test bars; melting.

ALUMINUM-ZINC—HEAT TREATMENT. Vergluetungsuntersuchungen an der Zink-Aluminium-Legierung von der Zusammensetzung Al_2Zn_3, H. Meyer. Zeit fuer Physik v 76 n 3/4 May 31 1932 p 268–80. Investigations of improvement of zinc-aluminum alloy Al_2Zn_3; changes of hardness and electric resistance produced in alloys by heat treatment; effect of alternating heat treatments on resistance; results suggest transformation of material from and into one or other of two crystal systems.

AUTOMOBILE ENGINES

[See *Diesel Engines (Automotive)*.]

AUTOMOBILES

MANUFACTURE—GREAT BRITAIN. Ford Manufacturing Practice. Machy (Lond.) v 40 n 1040 Sept 15 1932 p 733–61. Layout, equipment, and production methods at new Dagenham plant of Ford Motor Co., with particular regard to machining operations on rear axle, including data on output and tolerances; continuous broaching operation on valve guides.

SPRINGS. Der Hanft-Stabilisator. Automobiltechnische Zeit v 35 n 17 Sept 10 1932 p 416–17. Hanft stabilizer for uniform distribution over both springs of loads applied on one side of car either by turning corner, road shock, or uneven road surface; reduction of torsional stresses in springs; automatic lowering of center of gravity in curves while horizontal position of body is maintained.

BAKELITE

USE IN MACHINE CONSTRUCTION. How Bakelite Materials Are Solving Problems in Machine Design, F. C. Duston. Machy (N. Y.) v 39 n 1 Sept. 1932 p 25–9. Different forms in which bakelite raw materials are manufactured; properties of bakelite laminated and molding materials.

BEARINGS, ROLLER

LUBRICATION. Lubricants for Anti-Friction Bearings, O. L. Maag. Iron and Steel Engr v 9 n 8 Aug 1932 p 394–8 (discussion) 399–406. Testing methods and equipment for load-carrying ability and abrasion of oils and greases, developed by Timken Roller Bearing Co.

BINARY VAPOR SYSTEMS

ENGINE TESTS. Tests on Mixed Vapour Engine, L. Grosse. Steam Engr v 1 n 12 Sept 1932 p 541–3 and 560. Details of independent tests carried out in Pratteln, near Basle, Switzerland; necessary plant was set up by two firms, Buss A. G. and Caliqua A. G.; test results in tables and curves; mixed-vapor theory; general conclusions.

HEAT STORAGE. Eine elastische Kupplung der Arbeitsprozesse in Zweistoff-Dampfkraftwerken, H. Schulze. Elektrotechnische Zeit v 53 n 35 Sept 1 1932 p 839–40. Elastic coupling of processes in binary-vapor power plants; in non-interconnected plants, load fluctuations have to be suppressed and special accumulators are suggested.

BLAST-FURNACE GAS

STEAM GENERATION WITH. Generation of Steam From Blast-Furnace Gas, A. F. Webber. Iron and Steel Inst—Advance Paper Sept 1932 37 p. Importance of boiler efficiency as factor affecting works heat balance; boiler efficiencies attained by industrial plants compared with standards maintained in power-station boiler houses; suggestions for increasing efficiency of supplementary coal firing; economic results of steam-raising plant; cost estimates for three installations in different types of boiler plants. Bibliography.

BOILER FEEDWATER

TREATMENT. Modern Progress in Treatment of Boiler Feed Water. Eng and Boiler House Rev v 46 n 2 Aug 1932 p 81. Brief discussion of internal method of treatment; "conditioning" of boiler water with or without preliminary softening of feedwater; value of sodium phosphate as conditioning agent.

Zur Kenntnis der zementierenden insbesondere der silicatischen Bestandteile des Kesselsteines, F. Hundeshagen. Chemiker-Ztg v 56 n 53 and 54 July 2 1932 p 521–4 and July 9 p 542–4. Study of cementing, particularly silicate constituents of boiler scale, including calcium sulphate, calcium hydroxide, and magnesium; SiO_2 in raw water and in boiler water; phosphate treatment process; feedwater softening and silica removal; colorimetric analysis of reactions in scale; conclusions.

BOILERS

COMBUSTION CONTROL. Das *It*-Diagramm bei Feuerungsuntersuchungen, W. Schultes. Archiv fuer Waermewirtschaft v 13 n 9 Sept 1932 p 243–4. Application of *It*-diagram in investigation of furnaces; errors in determination of flue-gas losses; approximate calculation with *It*-diagram; graphs for direct calculation of flue-gas losses.

Some Notes on Automatic Combustion Control in United States, H. J. Sneden. Steam Engr v 1 n 10 July 1932 p 428–9. Hagan automatic combustion control operating at Harding Street station of Indianapolis Power and Light Co.; boilers are 11,810 sq ft cross-drum type, with 839.5 sq ft water-wall surface, stokers are of underfeed type, 10 retorts with 348.6 sq ft projected grate area and 6700 cu ft furnace volume, steam pressure at drum 440 lb gage, 725 F total temperature; diagram of controls.

ELECTRIC. Penzold High-Duty Electric Boiler for High-Tension Single-Phase and Three-Phase Current, A. J. Mosnaim. Eng Progress v 13 n 10 Oct 1932 p 223–6. Author arrives at conclusion as to chief characteristics which should be possessed by h-t electrode boiler of correct design; Penzold boiler is based upon these principles, proving that it was necessary to create entirely new boiler type.

FURNACES—RADIATION. Die Wertigkeit von Strahlungsheizflaechen, E. Eckert. Archiv fuer Waermewirtschaft v 13 n 9 Sept 1932 p 241–2. Valuation of radiant heating surfaces; for different tube arrangements employed as radiant heating surfaces, angle ratio, that is, ratio of furnace wall provided with cooling tubes, is given; results of graphic calculation for smooth tubes as cooling media.

GAS VELOCITY. Neuartige Dampferzeuger. Stahl u Eisen v 52 n 36 Sept 8 1932 p 881–2. New type of steam generator; development by Brown, Boveri & Cie of boiler with pressure-charged combustion chamber, making use of gas turbine.

Similar description previously indexed from various sources.

WATER-TUBE. Beitrag zur Berechnung des Wasserumlaufes in Dampfkesseln, P. Kohn. Waerme v 55 n 35 Aug 27 1932 p 589–90. Contribution to calculation of water circulation in boilers; simple graphic method of determining specific weight of steam-water mixture in boiler tubes, by means of which calculation of water circulation is improved and made more rapid.

New Water Tube Boilers at Stourport. Eng and Boiler House Rev v 45 n 11 May 1932 p 708, 710, and 712. New boilers of special tri-drum type, having 41 tubes in width by 15 tubes deep from front to back; each boiler has normal evaporation of 90,000 lb, max continuous overload rating of 100,000 lb, and peak capacity of 110,000 lb per hr; total heating surface of 12,099 sq ft and working pressure of 350 lb.

CAR RETARDERS

INSTALLATION. Car Retarders on Burlington, W. F. Zane. Ry Signaling v 25 n 9 Sept 1932 p 263–7 and 270. Eastbound classification yard at Galesburg, Ill., uses modern equipment and saves 28.6¢ per car on pay rolls; diagram of layout; retarders, power switch machines, signals, and control machines of Union Switch & Signal Co.; there are 12 retarder locations of which 8 are double and 4 single locations.

CARS, PASSENGER

AIR CONDITIONING. Speed Control Device for C. & O. Air Conditioned Cars. Ry Elec Engr v 23 n 9 Sept 1932 p 213 and 217. Air-conditioned cars used by Chesapeake & Ohio and equipped by Pullman Car & Manufacturing Corp., employ electric speed control device keeping compressor speed below set value and which facilitates control and protection of air-conditioning apparatus; power is transmitted to compressor through machine consisting of armature having no winding and field with separate excitation.

CONVEYORS

AUTOMATIC LOADING. Die selbsttaetige Foerdergutaufgabe bei fahrbaren Foerderern, W. Schultheis. Foerdertechnik und Frachtverkehr v 24 n 15/16 July 29 1932 p 176–8. Equipment for automatic loading of portable conveyors; causes for rare application; analysis of problem; requirements to be considered in design; description of some practical equipment.

BELT. Application of Rubber Belt Conveyors, H. S. Jude. Mech Handling v 19 n 8 Aug 1932 p 267–71. Securing of maximum service at minimum cost discussed under following heads: belt speed and width; strength of belt; quality of rubber; service for different quality of belting; flexing in service; size divisions; belts of special design; faulty loading conditions; etc.

Foerderbaender. Werkzeugmaschine v 36 n 14 July 31 1932 p 263–6. Layout of various conveyors with ball-bearing-mounted supporting and guiding rolls; capacity and speed.

Stainless Steel Belt Conveyor. Engineer v 154 n 4003 Sept 30 1932 p 337. Conveyors with stainless-steel bands, cold rolled in lengths of up to 400 ft and less than 1 mm in thickness made by Sandvik Steel Works, in Sweden.

DESIGN. Umlaufaufzuege als neuartige Foerdermittel, P. Nickel. Foerdertechnik und Frachtverkehr v 25 n 15/16 July 29 1932 p 169–76. Continuous chain and rope conveyor as novel type of materials-handling equipment; new types, one with single rope and one with two chains are analyzed with regard to stresses in load-carrying members; experimental results compared with method of calculation.

CUTTING TOOLS

CUTTING CAPACITIES. Selecting Right Cutting Tools in Modern Machine Shop, J. M. Highducheck. Machy (N. Y.) v 39 n 1 Sept 1932 p 30–2. Cutting capacities of high-speed, carbon, and cobalt steels determined by observation of tools in actual production and by tests at East Pittsburgh plant of Westinghouse Electric & Mfg. Co.

DIAMOND. Beseitigen der Schwierigkeiten Beim Einstellen von Diamantschneiden, A. Meyer. Werkstattstechnik v 26 n 14 July 15 1932 p 283–4. Dimensions of diamond tools and equipment for proper adjustment built by Earnst Winter & Sohn, Hamburg.

TUNGSTEN CARBIDE. Cemented Carbide Cutters in Milling, R. E. W. Harrison. Iron Age v 130 n 11 Sept 15 1932 p 408–10. On score that tungsten carbide cutters will operate about ten times number of hours previously obtained on same work with high-speed-steel cutters, it is contended that their greater use is warranted even considering negative factors in cutting-tool economics.

CYLINDERS

GAGING. Ueber Gleichdicke, A. E. Mayer. VDI Zeit v 76 n 37 Sept 10 1932 p 884–6. Analysis of difference between circle and constant-diameter figures with particular regard to formulation of maximum difference.

DIE-CASTING MACHINES

PRESSURE TYPE. Pressure Type Die Casting Machine. Iron Age v 129 n 3 Jan 21 1932 p 243; see also Foundry Tarde J v 47 n 838 Sept 8 1932 p 145. For manufacturing die castings of zinc-base alloys under pressure method, new die-casting machine of plunger or pressure type has been developed by Lester Die & Machine Co., Cleveland; advantages claimed for pressure over air-type machines.

DIESEL-ELECTRIC POWER PLANTS

GERMANY. Kompressor lose doppeltwirkende Zweitakt-Dieselmotoren von 12000 PSe, W. Laudahn. VDI Zeit—Dieselmaschinen—V special no 1932 p 10–17. Compressorless double-acting 2-cycle 10-cyl engines of 12,000 hp each, with bore and stroke of 600 by 900 mm built by MAN for Maerkische Elektricitaetswerk A.-G.

LULING, TEX. World's Most Efficient Power Plant, L. H. Morrison. South Power J v 50 n 7 July 1932 p 36–7. Diesel-electric power plant at Luling, Texas, since 1928 delivers net kw-hr at expenditure of 11,827 btu; record is average for entire year's operation with all variations of conditions and has been checked by Diesel Power Cost Committee of A.S.M.E.

DIESEL ENGINES

AUTOMOTIVE. Der Dieselmotor im Verkehr, F. Sass. VDI Zeit—Dieselmaschinen—V special no 1932 p 23–32. Progress in application of Diesel engines for propulsion of ships, locomotives, motor vehicles, and airplanes.

Der neue Michelmotor, A. Naegel and O. Holfelder. VDI Zeit v 76 n 35 Aug 27 1932 p 839–41. Engine consisting of units of three cylinders each arranged symmetrically around central combustion chamber; pistons acting on three individual interconnected crankshafts; operating diagrams of engine of 67 by 116 mm bore and stroke developing 40 hp at 2000 rpm.

Michel High-Speed Oil Engine and Its Performance, S. J. Davies. Engineering v 134 n 3478, 3479 and 3480 Sept 9 1932 p 290–3 Sept 16 p 333–6 and Sept 23 p 353–4. Engine working on 2-stroke cycle developed by Michelmotor-Gesellschaft of Hamburg; tests on single-star and two-star engines.

Saugrohr und Liefergrad, O. Kluesener. VDI Zeit—Dieselmaschinen—V special n 1932 p 107–10. Experimental and theoretical determination of optimum length of intake manifold or individual intake pipes for 4-cycle engines; effect of different manifold designs and air oscillations on volumetric efficiency.

Untersuchungen an der Dieselmaschine Strahleinspritzmachinen mit unterteiltem Verdichtungsraum und mit Waermespeicher, K. Neumann. VDI Zeit—Dieselmaschinen—V special no 1932 p 111–15. Thermodynamic analysis of operating cycle with particular regard to heat-storage effect; fuel consumption 0.225 kg per hp-hr; thermal efficiency of 30.4 per cent for single-cyl engine developing 15 hp at 1800 rpm.

Untersuchungen an Pumpen und Brennstoffventilen fuer Dieselmotoren, H. Triebnigg. VDI Zeit—Dieselmaschinen—V special no 1932 p 94–100. Experimental investigation of leakage losses, nozzle characteristics, static and dynamic factors of pressure formation during injection process; theoretical interpretation of results obtained at Humboldt-Deutz-motoren-A.-G.

Verbrennungsraum und Einspritzduese des "Linke"-Diesel-Schnellaeufers, Frey. VDI Zeit—Dieselmaschinen—V special no 1932 p 116–17. Combustion-chamber and spray-nozzle design of 4-cyl engine of 125 by 170 mm bore and stroke; 60 hp at 1100 rpm.

FUEL INJECTION. Die Einspritzverzoegerung bei kompressorlosen Dieselmaschinen, H. Heinrich. VDI Zeit—Dieselmaschinen—V special no 1932 p 143–8. Experimental investigation of factors causing injection lag in high-speed solid injection engine.

Fuel Vaporization and Its Effect on Combustion in High-Speed Compression-Ignition Engine, A. M. Rothrock and C. D. Waldron. Nat Advisory Committee Aeronautics—Report n 435 1932 25 p. Effects of injection advance angle, fuel boiling temperatures, fuel quantity, engine speed, and engine temperature; appreciable amount of fuel vaporized during injection. Bibliography.

PISTONS. I pistoni in lega di alluminio per motori Diesel, G. Mortimer and J. F. Paige. Alluminio v 1 n 3 May-June 1932 p 145–59. Aluminum-alloy-piston design for large Diesel engines; heat treatment and expansion characteristics; suggestions for casting.

VIBRATIONS. Messung der Drehschwingungen an einem 1500 PS-Dieselmotor, H. Baer. VDI Zeit v 76 n 28 July 9 1932 p 689. Measurement of torsional vibrations on 1500 hp 6-cyl Diesel engine; Wuelfel-Cachin elastic coupling eliminates influence of rotating masses on natural frequency of engine.

DIPHENYLOXIDE-VAPOR SYSTEM

BOILER. Dowtherm Boiler Supplies Vapor for High-Temperature Process, G. A. Yocum. Power v 76 n 4 Oct 1932 p 202. "Dowtherm" is name for mixtures of diphenyloxide with diphenyl or other phenolic and benzol derivatives made by Dow Chemical Co.; to use chemical mixture, Dow installed at its Midland (Mich.) plant boiler designed by Foster-Wheeler Corp. for this service; delivers to chemical plant Dowtherm vapor at 646 F and 50.3 lb gage pressure for use in distillation of high boiling-point chemical compounds.

POWER GENERATION. Diphenyl and Diphenyl Oxide for Power Generation, D. Brownlie. Steam Engr v 1 n 11 Aug 1932 p 476–9 and 495–6. Details of development; diagrams showing different arrangements for use of diphenyloxide as heat-transfer medium; diphenyloxide properties compared with water and mercury; equipment illustrated.

FILING MACHINES

GERMAN. Zweiseitige Feilmaschine, O. Scholl. Werkzeugmaschine v 36 n 13 July 15 1932 p 239–40. Filing machine in which file elements form endless-chain traveling over four rolls.

FLOW OF FLUIDS

MEASUREMENT. Blenden fuer die Stroemungsmessung, H. Euler. Archiv fuer das Eisenhuettenwesen v 6 n 3 Sept 1932 p 95–104. Diaphragm orifices for measurement of flow; formulas for calculation of diameter of orifice, with practical examples; structural design; cause and magnitude of errors.

FLOW OF WATER

PIPES. Gesetzmaessigkeiten der turbulenten Stroemung in glatten Rohren, J. Nikuradse. Forschungsheft 356 v 3 Sept/Oct 1932 36 p. Laws governing turbulent flow in smooth pipes in large range of Reynolds numbers; experimental plant constructed with which turbulent flow of water in pipes up to Reynolds number, $R = 3240 \times 10^3$, was determined; formulas developed for law of resistance and law of velocity of flow; comparison with von Kármán's formula of resistance. Bibliography.

FORGINGS, STEEL

FATIGUE. Fatigue Resistance of Unmachined Forged Steels, G. A. Hankins and M. L. Becker. Iron and Steel Inst—Advance Paper Sept 1932 17 p 2 supp plates. Results of investigation at National Physical Laboratory to compare fatigue resistance of unmachined heat-treated steel forgings with that of same materials when machined and polished; materials used.

GAS TURBINES

THERMODYNAMICS. Thermodynamik eines Gasturbinen-Aggregates, H. Kirst. Waerme v 55 n 36 Sept 3 1932 p 605–9. Thermodynamics of gas-turbine set; based on new diagram for gases at higher pressures, new method of calculating gas—water-vapor compressor for constant-pressure gas turbine with water injection is developed, and method is shown of determining adiabatic heat drop of turbine without use of gas-entropy diagram.

GASKETS

METALLIC. Plastic Metallic Packing. Engineer v 154 n 4003 Sept 30 1932 p 338. New type of packing, marketed under trade name of Sealite made by R. C. Taylor and Co.; consists of 87 per cent of finely divided non-fibrous lead-base alloy, to which has been added 10 per cent of graphite and small amount of long-strand asbestos.

GYROPLANES

WILFORD. Safety—With Performance, P. E. Hovgard. Aviation Eng v 7 n 3 Sept 1932 p 12–13. Tests on Wilford Gyroplane with rigid feathering rotor and fixed wing; lift drag and L/D of 4-ft rotor model; pitching moments throughout flight range for gyroplane of 1800 lb loaded 2.6 lb per sq ft of disk area.

HEAT-INSULATING MATERIALS

ALUMINUM FOIL. Aluminum Foil Heat Insulation, T. A. Solberg. Am Soc Naval Engrs—J

v 44 n 2 May 1932 p 200–5 1 supp plate. Thin, pliable, sheets of aluminum foil can be applied in such manner as to form efficient heat-insulating material; advantages of aluminum foil; principal difficulties encountered.

HEAT TRANSMISSION THROUGH. Report on High Temperature Heat Insulation: Correlation of Existing Data, M. L. Nathan. Instn Chem Engrs—Trans v 9 1931 p 177–90. Heat transmission through insulators and from surface of insulators; formula for compound thickness; qualities required of insulators for high temperatures; structural properties of insulation materials; fallacy of regarding surface temperature as measure of heat transfer.

INSULATION PRINCIPLES. L'isolation thermique et les calorifuges en chimie industrielle, A. Matagrin. Revue de Chimie Industrielle v 41 n 486, 487 and 488 June 1932 p 171–6, July p 199–205 and Aug p 225–32. Heat insulation and insulators in industrial chemistry; principles of insulation; insulation by air layers; cork and peat as insulating materials; fibrous silicates—mineral and magnetic fabrics; natural silk as insulating material; diatomite or kieselguhr; carbonated magnesia.

HEAT TRANSMISSION

RESEARCH. Neue Ergebnisse der waermetechnischen Forschung. VDI Zeit v 76 n 37 Sept 10 1932 p 895–8. Abstract of papers before V.D.I. Committee for heat research at Duesseldorf meeting, June 24 and 25, by R. Hase, E. Schmidt and W. Sellschopp, R. Plank, R. Hermann, A. Schack, L. Schiller and Weise, H. Barth, W. Piening, M. Jakob, S. Erk and H. Eck, F. Roecke, A. Heidrich, W. Fritz and W. Linke, G. Eichelberg and Salzmann, H. Mehlig and G. Zerkowitz.

HONING MACHINES

INTERNAL HONING. Developments in Internal Honing, J. E. Andress. Iron Age v 130 n 14 Oct 6 1932 p 526–9 and 546. Operations and applications of honing machines with data on accuracy; classification of work adaptable to honing.

HYDRAULIC TURBINES

CAVITATION. Cavitation in Large Hydraulic Turbines, A. P. Thurston. Engineering v 134 n 3482 Oct 7 1932 p 415. Difficulty being experienced owing to cavitation of turbine blades; if corrosion is due to flow in boundary layer, it would appear that solutions may be obtained in one of ways known in aeronautics for destroying opposing pressure gradients and preventing surfaces of discontinuity or stalling.

DRAFT TUBES. On Model Experiment of Water Turbine Draught Tubes, O. Miyagi. Tohoku Imperial Univ—Technology Reports v 10 n 3 1932 p 30–44. Theory of flow in draft tube; flow is in state of compound vortex with central core rotating like solid bar; neither compound vortex nor cavitation follows law of similarity; relation between efficiencies of actual draft tube and model.

HIGH-EFFICIENCY. 4,500-Hp. Hydro Turbine Gives 93.9% Efficiency, L. F. Harza and E. Floor. Power v 76 n 4 Oct 1932 p 188–90. Maximum turbine efficiency and unit efficiency of 90.7 per cent in hydroelectric plant of Central Power and Light Co., Eagle Pass, Tex.; station comprises three units at end of irrigation diversion from Rio Grande River, returning water to river about 10 mi above Eagle Pass, Tex.; each unit has normal rating of 4000 kva at 0.80 pf for generator, and 4500 hp at 225 rpm under 81-ft head, for turbine.

KAPLAN. Kaplan Turbines at Safe Harbor Hydroelectric Plant, L. M. Davis and G. W. Spaulding. Elec Eng v 51 n 10 Oct 1932 p 728–33. Kaplan turbines at plant in Baltimore, Md., having automatically adjustable blades installed; type is used in all of 6 units of initial installation, each rated at 42,500 hp under rated head of 55 ft; engineering studies in connection with these units required construction of new hydraulic laboratory for testing model turbines. Before Am. Inst. Elec. Engrs.

HYDRODYNAMICS

SHOCK. Ueber Stoss- und Gleitvorgaenge an der Oberflaeche von Fluessigkeiten, H. Wagner. Zeit fuer Angewandte Mathematik und Mechanik v 12 n 4 Aug 1932 p 193–215. Theoretical mathematical discussion of shock and gliding on surfaces of fluids, neglecting effect of gravity.

INDUSTRIAL MANAGEMENT

COST ACCOUNTING. Eine uebersichtliche Rohbilanz bei Kurzfristiger Erfolgsrechnung, K. Gehlen. Maschinenbau v 11 n 17 Sept 1 1932 p 353–8. Facilitating control of manufacturing enterprises by suitable arrangement of various cost items on balance sheet illustrated by numerical example; static and dynamic balance theory.

Entwicklung der Kalkulationsunterlagen fuer Maschinen-Feilarbeiten. Maschinenbau v 11 n 13 July 7 1932 p 281–3. Development for basis of cost calculation for filing-machine work; classification of files according to output.

Selbstkostenberechnung in Schmiedenetrieben auf Zeitgrundlage, E. Czermak. Stahl u Eisen v 52 n 36 Sept 8 1932 p 869–79. Cost accounting in forge-shop practice based on time analysis; former method employed and its defects; new system based on nominal time requirement; practical examples.

FATIGUE. Fatigue as Factor in Costs, H. W. Streck. Nat Assn Cost Accountants—Bul v 13 n 24 Aug 15 1932 p 1616–24. Nature and cause of fatigue; methods of reducing fatigue and resulting increase in production; methods of including fatigue allowance in time study; duty of cost accountant is to oppose quota that will force any operator beyond fatigue point. Bibliography.

PRODUCTION CONTROL. Kurventafel, Fluchtlinientafel und Rechenschieber zur Ermittlung der Guenstigsten Losziffer, W. Von Schuetz. Werkstattstechnik v 26 n 16 Aug 15 1932 p 313–15. Curve chart, nomogram, and slide rule for determination of optimum lot size.

TIME STUDY. Zeitstudien in der Freiformschmiede zur Ermittlung von Richtwerten fuer Zeitvorgabewerte, C. Schlingmann. Maschinenbau v 11 n 15 Aug 4 1932 p 320–2. Examples of accurate time setting for hand forging operations according to Refa.

INTERNAL-COMBUSTION ENGINES

COOLING. Engine Cooling, L. Schwitzer. Soc Automotive Engrs—J v 31 n 3 Sept 1932 p 378–83. Theory of liquid-cooling, heat-transfer, and temperature-balance equations; fan selection and installation; location of pump; water-jacket design.

SCHWARZ CYCLE. Schwarz-Cycle Engine. Motive Power v 3 n 7 July 1932 p 8–9. Supercharging by means of stepped piston acting as compressor on down stroke; use of fuel oil with spark ignition; specific consumption 0.52 lb per hp-hr.

[See also *Diesel Engines.*]

JIGS AND FIXTURES

SPHERICAL WORK. Werkzeuge, Vorrichtungen und Einrichtungen zum Drehen und Schleifen kugliger Werkstuecke, A. Winter. Maschinen Konstrukteur v 65 n 13/14 July 10 1932 (Werkzeug) p 77–9. Turning and grinding of spherical work by means of special tools, jigs, and fixtures.

LOCOMOTIVES

ARTICULATED. Single Expansion Articulated Locomotives, M. Noble and P. T. Warner. Baldwin Locomotives v 11 n 2 Oct 1932 p 3–11. General type is one having two groups of driving wheels, with independent single-expansion cylinders operating each group; to provide flexibility needed for curving, front and rear frames are connected by hinged ball-and-socket joint; rear frames are held in rigid alignment with boiler; forward end of boiler is supported on front frames through sliding bearer; various types illustrated.

Experimental Locomotives for Baltimore & Ohio Railroad, E. C. Poultney. Ry Engr v 53 n 632 Sept 1932 p 332–8. Equipment of 4-6-2 and articulated 2-6-6-2 types, one of each type having water-tube firebox, and 2-6-6-2 engines having 5 ft 10 in. coupled wheels; locomotives illustrated; indicated horsepower and cylinder tractive effort curves, locomotive No. 7400.

Steam Locomotive Design: Data and Formulae, E. A. Phillipson. Locomotive v 38 n 479 and 480 July 15 1932 p 243–7 and Aug 15 p 277–8. Mathematical design analysis pertaining to direct (horizontal) loads on coupling rods and axle boxes; general remarks on coupling rods; outside crankpins.

DIESEL. Oil Engine Traction—III and IV, A. E. L. Chorlton. Roy Soc Arts—J v 80 n 4159 and 4160 Aug 5 1932 p 910–27 and Aug 12 p 931–45. Lomonosoff locomotives of Russian State Railways; locomotives designed by Krupp; locomotives on Danish State Railways by Frichs and by Burmeister and Wain; comparison of mechanical, electric, and compressed-air transmissions; characteristics of representative rail cars; operating costs for different types of Diesel locomotives.

HIGH-PRESSURE. C.P.R. Multi-Pressure Locomotive, H. B. Bowen. Ry Age v 93 n 10 Sept 3 1932 p 330–2 and 338. Operation and maintenance of Canadian Pacific locomotive No. 8000; low-pressure boiler is fed with Elesco CF-1 feed pump and provided with Hancock inspirator as auxiliary; at present there is increased maintenance cost of multi-pressure over conventional locomotives; tables showing performance as compared with No. 5900 (T-1 class) on heavy grades. Before Am. Soc. Mech. Engrs.

Development of Multi-Pressure Locomotive, F. A. Schaff. Ry Age v 93 n 9 Aug 27 1932 p 290–4. C.P.R. No. 8000, Class T42, built for comparison with road's Class T1a; Elesco multi-pressure system consists of three separate units: closed circuit, high-pressure boiler, and low-pressure boiler. Before Am. Soc. Mech. Engrs.

CANADA. Machinery, Chassis and Tender of C.P.R. Locomotive, J. B. Ennis. Ry Age v 93 n 10 Sept 3 1932 p 328–30. Particulars of locomotive No. 8000 of Canadian Pacific Railroad; three-cylinder arrangement was used with single crank axle as in Schmidt-Henschel locomotive, with middle high-pressure and two outside low-pressure cylinders; distribution of power and steam. Before Am. Soc. Mech. Engrs.

VALVE GEARS. Meier-Mattern Oil Pressure Valve Gear Applied to Locomotives. Locomotive v 38 n 479 July 15 1932 p 248–52. Details of system with some particulars of results attained in actual practice; diagrams of general arrangement and valve lift; comparison of trial runs with three locomotives of Netherland railways with Meier-Mattern oil-pressure valve gear, Walschaerts valve gear, and Lentz poppet valve gear; indicator diagrams.

MACHINERY

CONTROL. Magnetic Control Permits Design Flexibility, H. E. Hodgson. Machine Design v 4 n 9 Sept 1932 p 31–4. Automatic control of mechanical motions or control from remote point suitable to use of magnetic devices; properties of these controls and how they may be applied.

MALLEABLE-IRON CASTINGS

ANNEALING. Short-Cycle Malleableizing, H. W. Highriter. Am Foundrymen's Assn—Trans v 3 n 4 June 1932 p 72–87. Reduction of time in producing malleable-iron castings from white-iron stage, by increasing rate of graphitization and by bringing commercial annealing cycle closer to minimum required; reduction in depth of decarburization, favoring more rapid machining; furnace costs and estimated annealing costs. Bibliography.

MATERIALS

DETERIORATION. Fundamentals in Problem of Resistance to Deterioration, H. S. Taylor. Am Soc Testing Matls—Advance Paper mtg June 22 1932 34 p. Fundamental reactions in deterioration are oxidation processes involving oxygen, steam or other oxidizing agents, and reactions of polymerization, decomposition, and depolymerization; control of deterioration is inverse of historical occupation of chemist, prime concern being promotion of chemical reactions.

DRAWING. Principles of Lubrication in Cold Drawing Sheet Steel, H. A. Montgomery. Am Soc Steel Treating—Advance Paper n 9 mtg Oct 3–7 1932 8 p. Principles of lubrication in drawing, pressing, and shaping of sheet-metal products; chemical and physical properties of natural lubricants; compounded lubricants generally furnished under secret formula.

Sur les résultats fournis part les essais d'emboutissage et sur leur relation avec les essais de traction, H. Fournier. Academie des Sciences—C R v 195 n 4 July 25 1932 p 327–9. Results of deep-drawing tests and their relation to tensile tests; comparison of methods of Siebel and Pomp, Persoz and Erichsen; tests on 67–33 brass, commercial 99.5% aluminum, duralumin, and magnesium.

Sur les essais d'emboutissage suivant le methode Siebel et Pomp, H. Fournier. Academie des Sciences—C R v 195 n 2 July 11 1932 p 142–4. Siebel and Pomp's deep-drawing test; after theoretical examination, author concludes that this method is more sensitive than those of Erichsen or Persoz; sensitivity is greater in application to metals of very high tensile elongation; on other hand, it is less general.

ELASTIC HYSTERESIS. Die Veraenderlichkeit der Werkstoffdaempfung, P. Ludwik and R. Scheu. VDI Zeit v 76 n 28 July 9 1932 p 683–5. Changes in damping capacity of materials with frequency of stress cycle determined by measurement of area of hysteresis loop; effect of temperature in comparative endurance tests with and without cooling.

FATIGUE. Importance of Fatigue of Metals to Engineering Design, T. A. Solberg and H. E. Haven. Metals and Alloys v 3 n 9 Sept 1932 p 196–9. Causes of fatigue failures in various machine parts including crankshafts, turbine shafts, pinions, streamline wires, boiler drums, etc.

Significance and Limitations of Fatigue Test Results, R. E. Peterson and H. F. Moore. Iron & Steel Industry v 5 n 12 Sept 1932 p 437–8. Term fatigue should be used only in case of failure by spreading crack; endurance-limit tests for fatigue resistance; ductility no criterion of endurance.

MOLDS, FOUNDRY

SAND-CEMENT. Revolutionary Method in Moulding Practice, L. Maillard. Foundry Trade J v 47 n 838 Sept 8 1932 p 138–9. Method of making iron and steel castings which utilizes sand-cement mixture of such character that boxes and drying stoves are eliminated; 13-ft long roll cast without box parts; oil-sand compositions used; it seems possible that method may replace dried-sand molds and all types of foundry work with exception of green-sand molding.

MOLYBDENUM STEEL

PROPERTIES. Some Molybdenum High Speed Steels, J. V. Emmons. Am Soc Steel Treating—Advance Paper n 11 mtg Oct 3–7 1932 29 p. Properties and performance of several types; hardness, strength, and plasticity; microstructures; cutting quality; comparison between molybdenum steels and some types of tungsten high-speed steels; new type of molybdenum steel carrying 1/4 as much tungsten as molybdenum is found to be superior in many respects to types previously examined.

PLATES

STRESSES. Das Ausknicken von allseitig befestigten und gedrueckten rechteckigen Platten, K. Sezawa. Zeit fuer Angewandte Mathematik und Mechanik v 12 n 4 Aug 1932 p 227–9. Approximate computation of buckling limit of rectangular plates fixed and subjected to pressure along all its edges.

Zur Sratik eingespannter Rechteckplatten, H. Schmidt. Zeit fuer Angewandte Mathematik und Mechanik v 12 n 3 June 1932 p 142–51. Theoretical mathematical discussion of stresses in thin rectangular plates supported along one pair of opposite edges and clamped along other; application of method to case of plate clamped along entire periphery.

PRESSURE VESSELS

WELDING. Pressure Vessels of Welded Construction, J. C. Hodge. Eng J v 15 n 9 Sept 1932 p 417–22. Properties of satisfactory welded seams of pressure vessels, as regards tensile strength, resistance to impact and fatigue, chemical composition, etc; testing procedure for such joints and precautions which must be taken in relieving stresses set up by welding process.

PULVERIZED-COAL FIRING

INSTALLATION FOR. Pulverizing Coal of High Moisture Content. Power Plant Eng v 36 n 18 Oct 1932 p 710–11. Boiler-room installation recently completed by Orenda Corp. at Wilmington, Ill., paper mill; is excellent example of rebuilding old boiler to obtain higher efficiency and capacity because of successful pulverization and burning of local coal with moisture content of 14 per cent; installation has also burned local 3/16 in. duff containing 20 to 22 per cent ash, 18 to 20 per cent moisture, and 1880 F fusion temperature ash.

PUMPS, CENTRIFUGAL

DESIGN. Effect of Size and Shape of Passages of Guide Vanes Upon Characteristics of High-Pressure Single-Stage Centrifugal Pump, T. Kasai. Soc Mech Engrs, Japan—J v 35 n 183 July 1932 p 666–77. Report of experimental research comparing effect of differences in broadness of passage of guide vane, its shape, outlet angle, etc. (In Japanese.)

Hilfseinrichtungen fuer selbstansaugende Kreiselpumpen, F. Neumann. VDI Zeit v 76 n 37 Sept 10 1932 p 893–4. Review of practice relating to auxiliaries self-priming centrifugal pumps.

RAIL MOTOR CARS

GASOLINE-ELECTRIC. 900-Hp. Rail Car for Santa Fe. Ry Elec Engr v 23 n 9 Sept 1932 p 214–16. 900-hp articulated, gas-electric rail car of Atchison, Topeka & Santa Fe represents highest-powered unit built for any railroad in country; design unusual as power-plant section is separate from baggage and express compartment section and two are joined by center articulated-type truck; length 90 ft; weight 245,000 lb; power capable of handling four heavy passenger trailers; speed up to 80 mph.

IRELAND. Diesel Rail-Cars, Great Northern Ry. (Ireland.) Locomotive v 38 n 480 Aug 15 1932 p 280–2. Two cars "A" and "B" constructed; "A" weighs 18 3/4 t, driven by A.E.C. (Ricardo head) 6-cyl oil engine developing 120 hp at 1800 rpm, fitted with Daimler fluid flywheel and epicyclic self-changing gear box; "B" weighs 21 t, driven by Gleniffer oil engine developing 120 hp at 900 rpm, fitted with Tilling-Stevens system of electrical transmission; sketches.

STEAM. New Steam Railcars for Turkish State Railways. Ry Engr v 53 n 633 Oct 1932 p 362–3. Steam rail motor cars constructed by Maschinenfabrik Esslingen water is freed from gas and air by preheating device which warms it to about 200 c; cyl 9 27/32 in. diam; driving wheels 4 ft 7 1/8 in.; wheelbase total 57 ft; boiler working pressure 25 atm; max tractive effort 8000 lb; max normal speed 46.6 mph.

STREAMLINE. Expériences aérodynamiques sur les formes extérieures a donner aux autorails, M. Leboucher. Revue Générale des Chemins de Fer v 51 n 1 July 1932 p 3–18. Aerodynamic experiences with external shapes of rail motor cars; model test at Issy-les Moulineaux wind tunnel by Compagnie des Chemins de fer du Midi; efficiency of aerodynamic brake.

RIVETING MACHINES

ELECTRIC CONTROL. Automatic Control of Holding Time in Hydraulic Riveting, L. C. Ruber and H. F. Transue. Baldwin Locomotives v 11 n 2 Oct 1932 p 23–6. To determine definitely proper length of time for holding pressure on to rivets, Baldwin Locomotive Works carried on wide series of experiments in making sample joints, using different diameters of rivets, as result chart was prepared to show holding time required for each diameter of rivet; electrical timing device was designed, built, and patented.

ROLLS

FAILURES. Cracking and Fracture in Rotary Bending Tests, F. Bacon. Engineering v 134 n 3480 Sept 23 1932 p 372–6. Experimental investigation to interpret markings of simple geometrical form frequently found on freshly fractured faces of chilled-iron rolls used in hot mills of sheet and tin-plate works.

SAFETY VALVES

DESIGN. Design of Safety Valves for High Pressure Boilers—I, II, and III, L. E. Adams. Eng and Boiler House Rev v 45 and 46 n 12, 1 and 2 June 1932 p 759–60 July p 40 and 42 July p 112 and 114. June: Methods of calculating and designing high-pressure safety valves. July: Comparative properties of six different springs given in table; coefficient of discharge; values from Steam Nozzles Research Committee of Institute Mechanical Engineers' experiments. Aug.: Actual coefficient of discharge.

SCREW THREADS

MEASUREMENT. Die Messung des Flankendurchmessers dreinutiger Gewindebohrer, G. Berndt. Zeit fuer Instrumentendunde v 52 n 7, 8 and 9 July 1932 p 307–19 Aug p 353–64 and Sept p 408–16. Mathematical analysis of accuracy of methods of measuring diameter of taps with three flutes, including use of wires, cones, cylinders, prisms, etc.; experimental verification.

STRESS ANALYSIS. Determination of Stress Concentration in Screw Threads by Photoelastic Method, S. G. Hall. Univ Ill—Eng Experiment Station—Bul n 245 v 29 n 77 May 24 1932 17 p. Determination of stress in transparent specimen by passing plane polarized light through specimen and measuring phase difference of two emerging light vibrations by means of Babinet compensator consisting of two quartz wedges; results of tests show stress in American Standard thread about 40 per cent greater than that in Whitworth thread.

SHAFTS

VIBRATIONS. Dauerbrueche durch Drehschwingungen an elektrischen Antrieben, W. Peineke. Maschinenbau v 11 n 15 Aug 4 1932 p 313–16. Examples of failure of shafts, gears, and fans due to vibrations in shafting of electric drive.

SPRING STEEL

TESTS. Spring Steels, E. Houdremont and H. Bennek. Metallurgist (Supp to Engineer) Sept 30 1932 p 141–3. Results of investigation shown in tables; addition of alloying elements does not greatly increase fatigue resistance of unmachined springs and, in general, laminated springs can safely be designed on limiting fatigue stress in material of plus or minus 9 1/2 t per sq in., and helical springs on fatigue stress (torsional stress) of plus or minus 6 1/2 t per sq. in.

SPRINGS

HELICAL. Le molle elicoidali, I. Musatt and G. Calbiani. Metallurgia Italiana v 24 n 6 and 7 June 1932 p 465–84 and July p 549–572 6 supp plates. Design, manufacture, and heat treatment of helical springs; physical properties and composition of materials; testing methods and causes of failure.

STEEL AND RUBBER. Steel and Rubber Springs. Mech World v 92 n 2384 Sept 9 1932 p 243–4. Spring for reducing shock should have maximum amount of stroke, and should be capable of storing energy; springs for this purpose can be divided into two kinds, those in which length is less than diameter and for which rubber is superior, and those in which length is greater than diameter, and for which steel is best used.

STEAM ACCUMULATORS

MARGUERRE. Making Steam Generators Responsive to Variable Demands, C. S. Darling. Mech World v 92 n 2383 Sept 2 1932 p 224–7. Particulars of Kiesselbach constant-pressure storage; elimination of certain drawbacks of system by modification according to Marguerre system; flexibility is obtained by bypassing surplus steam to accumulator and condensing same during low loads, and when extra demand occurs steam is not condensed or bypassed; accumulator plant at Mannheim.

STEAM PIPE LINES

HIGH-PRESSURE. Une tuyauterie de vapeur a haute pression et haute temperature, G. Beaufaux. Union des Ingénieurs sortis des écoles speciales de Louvain n 2 1932 p 3–35. Vapor pressure and high temperature of steam pipe lines discussed under heads: materials resistance, calculation, and empirical methods, test methods based on stability of design first employed by Compagnie de Fives-Lille in power plant of d'Issy-les-Moulineaux; results of tests on steel and flanges.

UNDERGROUND. Die Waermeverluste von Rohrleitungen im Erdreich, H. Petri. Waerme v 55 n 38 Sept 17 1932 p 641–3. Heat losses in underground pipe lines; data on degree and influence of heat conductivity and calculation of heat losses based on practical tests.

STEAM POWER PLANTS

BERLIN. West Station Berlin; A Modern European Plant, W. E. Wellmann. Power v 76 n 4 Oct 1932 p 186–7. Berliner Staedtische Elektrizitatswerke, A.G. planned for 355-lb pressure and 797 deg steam at throttle; boilers designed for 454 lb per sq in.; wage situation, cost of material and load conditions led to selection of turbines of 34,000-kw capacity; probable necessity of frequent starting and stopping of turbines also influence selection of size; 6 units of 34,000 kw installed, together with 2 house turbines of 12,000 kw.

FRANCE. Vitry-Sud Generating Station (Centrale Arrighi) Paris, D. Brownlie. Steam Engr v 1 n 10 July 1932 p 437–40. Arrighi power plant at Vitry-Sud, of l'Union l'Electricte, Paris, designed for 500,000 kw; present contribution is attempt to give in condensed form essential details of plant and equipment of station. Similar descriptions previously indexed from various sources.

GERMANY. Kraftwerk West—XII, W. Schleiermacher. Siemens Zeit v 12 n 9 Sept 1932 p 303–12. Details of turbine equipment at West Power Plant; plant consists of 6 turbo-generators of 34,000 kw each, made by Siemens-Schuckertwerken in Muelheim/Ruhr; back-pressure unit of 1000 kw and 2 house units of 12,000 kw; steam pressure 25 atm at 395 deg which may be increased to 32 atm at 425 deg; sectional drawings; acceptance tests results of main turbines and house units.

GREAT BRITAIN. Ironbridge Super Power Station. Elec Times v 82 n 2134 Sept 15 1932 p 319–21. Station of West Midlands Joint Electricity Authority; equipped with three tri-drum Stirling-type boilers of 400 lb pressure and 800 F at superheater; steam turbine, B.T.H. 2-cyl. double-flow, impulse type; stainless-steel impulse blading throughout; speed 1500 rpm; data on switchgear and electric equipment; circulating-water-pump house; coal and ash-handling plant.

INDUSTRIAL.—Automatic Regulators Aid Process-Steam Production, F. A. Eyles. Power v 76 n4 Oct 1932 p 179–81. Proper balance between power load and process-steam requirements must be maintained in many industries if production cost is to be minimum; means of doing this automatically; diagrams for current and low-pressure turbine control and automatic load regulator combined with current limit relay; elementary connections for frequency relay to trip two solenoid-operated valves.

STEEL

FATIGUE. Understressing and Notch Sensitiveness in Fatigue, J. B. Kommers. Eng News-Rec v 109 n 12 Sept 22 1932 p 353–5. Report on new original test showing that "coaxing" effect of repeated understressing is greatest when initial stressing is close to endurance limit and may be increased by progressive raising of stress; notches weaken cast iron less than steel; increase above virgin endurance limit due to coaxing; discussion of effect of homogeneity; increase of cycle resistance; effect of square notches on endurance limit.

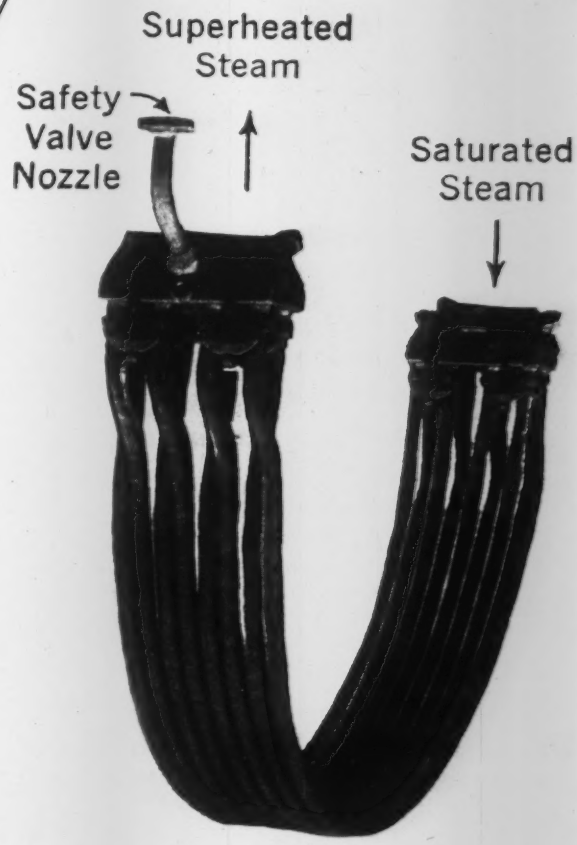
HARDENING. Einiges aus der mechanische Oberflaechenbehandlung im Automobilbau, G. Prachtl. Werkzeugmaschine v 36 n 11 June 15 1932 p 195–9. Procedure of obtaining hard surface layer by nitridation and by double Duro method developed by Bergische Stahl industrie; hardening machine with oxyacetylene heating.

Don't Fail to visit Booth 57

If you plan to be in New York during power show week, let us know and we will be glad to send you a ticket. We would like to have you come in and ask questions—you will not be obligated in any way. If you have a horizontal return tubular boiler, you owe it to yourself to visit Booth 57.

and see

A New Fuel Saver



Those owners and operators of power plants with horizontal return tubular boilers, are especially invited to our booth at the New York Power Show, to be held December 5th–10th, at the Grand Central Palace, New York, N. Y.

There will be on display models of the new Elesco h. r. t. superheater, which reduces fuel costs and speeds up production . . . by making easily available all the advantages of superheated steam operated at a nominal cost.

In one plant, savings in fuel amounted to 26.7 per cent and in water 20 per cent, by applying Elesco superheaters to h.r.t. boilers.

Another plant—a progressive power laundry—reports their coal saving was at the rate of $144.00 or 24 tons for 17 days, with approximately the same plant output. The output of flat-work ironers was increased 70 per cent.

These are typical ways in which this new Elesco superheater reduces fuel and other operating costs. It is simple in design and its cost is so low that it is quickly repaid by resultant savings.

The new Elesco h. r. t. superheater is standard for all h. r. t. boilers. Installation is simple and easily made by your own men in minimum time—without changes of settings or arches. *No attention required in operation.*

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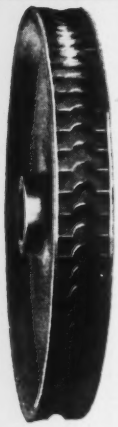
TERRY

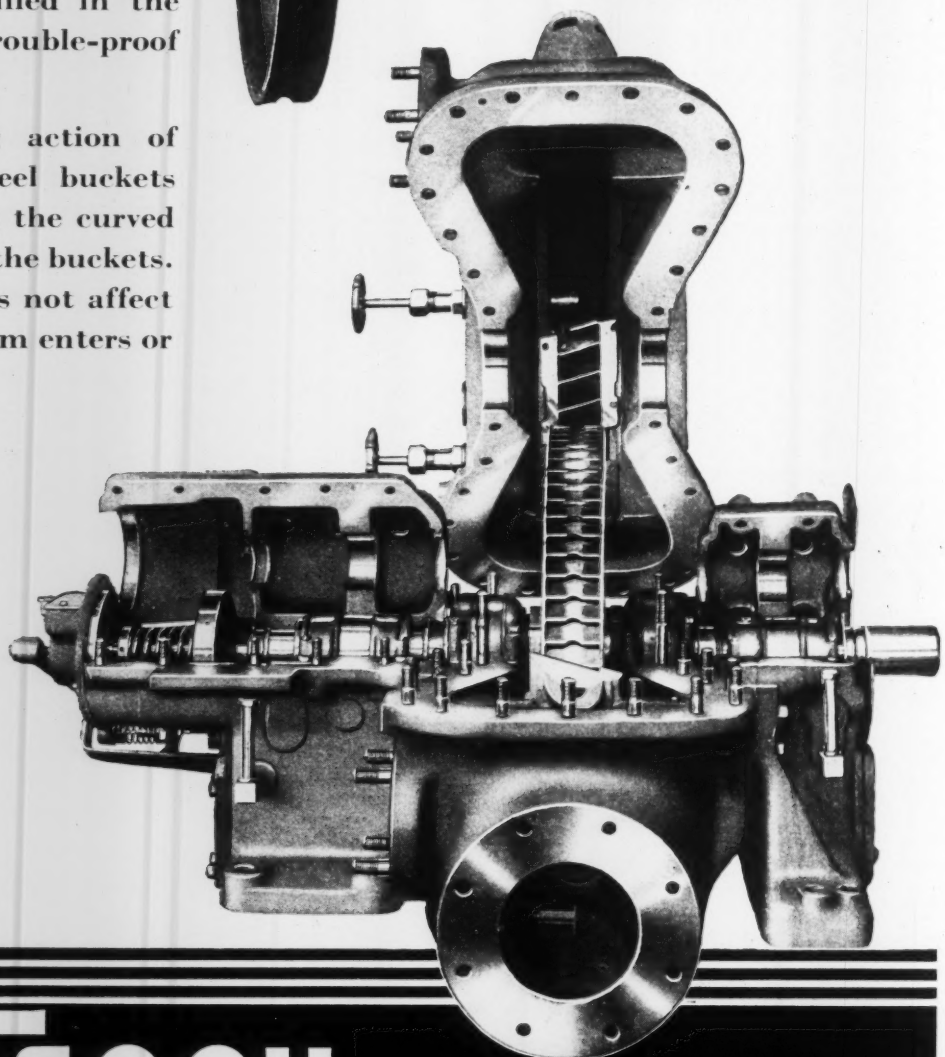


The Terry TROUBLE-PROOF Wheel

The Terry wheel, made from solid steel with buckets milled in the edge, is as simple and trouble-proof as a wheel could be.

The power producing action of the steam in the wheel buckets takes place entirely on the curved surfaces at the back of the buckets. Wear at this point does not affect the angle at which steam enters or leaves the wheel.

Therefore, Terry wheel turbines will maintain their original capacity for years. Ask for descriptive leaflets.

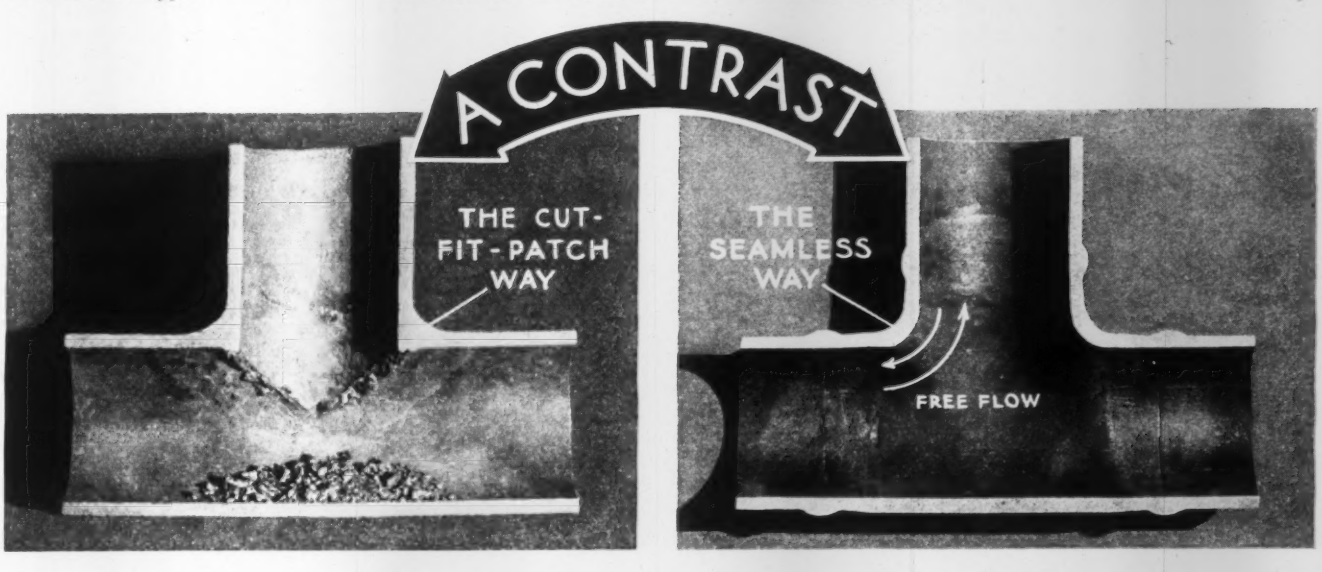


T-1090

The TERRY Steam Turbine Co.

TERRY SQUARE, · · HARTFORD, CONNECTICUT

TURBINES, GEARS SHAFT COUPLINGS



» » that you can't AFFORD to overlook

WELDED piping? Yes, by all means—but what KIND of welding? These contrasting illustrations may help you to answer that question . . . . *correctly*.

At the left is the camera's record of what happened when a branch pipe was welded into a straight run. Note how the slag dropped into the pipe when the aperture was cut. Also observe the unavoidable ragged edges of the weld, in spite of the fact that it was done by a skilled welder.

At the right is a far different story—the clean workmanlike result that is obtained when the Taylor Forge Seamless Tee is used.

No burning or cutting is necessary—no slag enters the pipe. Three simple—and therefore accurate—roundabout welds that any welder can properly accomplish, give a final result that an expert could not approach the other way.

The cut-fit-patch tee with its jagged corners violates all good piping standards. The Taylor Seamless Tee offers a slag-free piping system with proper contour, full flow at the outlet, and uniform strength to withstand service strains.

Taylor Forge Fitttings include:

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- LONG RADIUS ELBOWS
- FULL BRANCH TEES
- REDUCING TEES
- BULL PLUGS
- REDUCING NIPPLES
- WELDING NECK FLANGES

All Sizes—All Seamless

Wherever pipe is joined there is a Taylor Forge fitting that upholds the traditions of Taylor Forge—for extreme accuracy, correct design, and precise, unvarying physical and chemical properties.

All fittings are SEAMLESS. All are selectively reinforced—strengthened at all points where stresses usually occur, in exact proportion to the stresses that are encountered in typical piping systems. The machine-tool beveled ends—an additional feature—greatly facilitate the making of simple roundabout welds that insure a uniformly strong weld. All Ells are provided with short tangents which simplify alignment. The line is complete, as listed opposite, and made in standard and extra-heavy pipe thickness.

When you use or specify Taylor Forge fittings your responsibility is supported by an organization that has had unsurpassed experience in the piping field. Make Taylor Forge standards, YOUR standards! Write for data.

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TAYLOR FORGE

SEAMLESS STEEL FITTINGS FOR WELDING

It's not too late to INCREASE *the* COMPRESSION *ratio of your* 1933 *models*

Valuable improvements in performance characteristics that will give your car competitive excellence are ready at hand. They involve no expensive last-minute retooling or redesigning.

THE permissible limits of compression ratio are now approached by at least one manufacturer in *every* price class—yielding a reward in performance gains that can be had in no other way. Factors which have worked to raise these permissible limits leave a wide margin for improvement open to most 1932 engines.

Higher compression will make your 1933 car better on each of these counts:

(1) **More power and speed.** Higher peak power engine speed resulting from increased fuel efficiency.

(2) **Faster acceleration.**

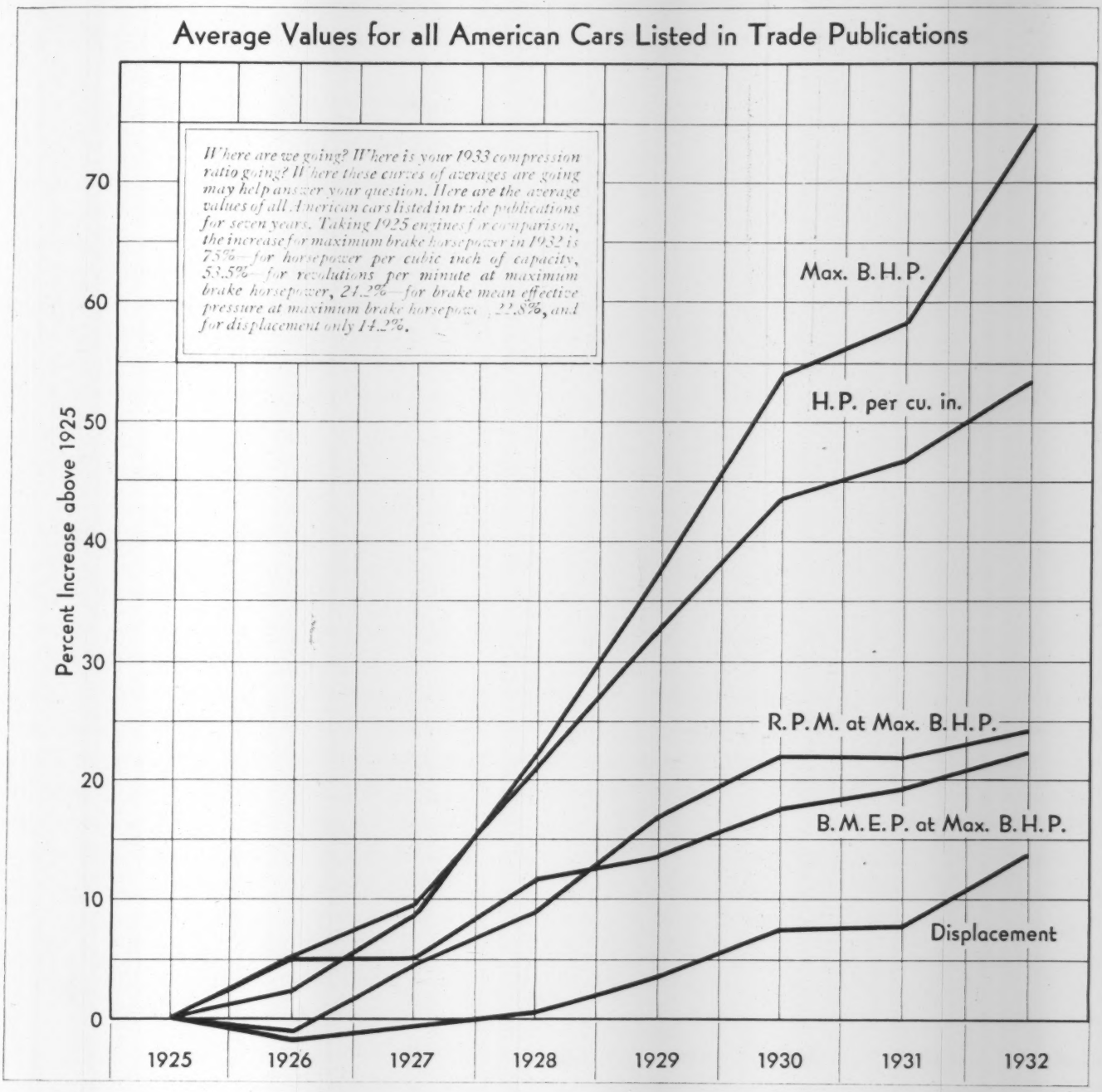
(3) **Better hill climbing ability.**

(4) **Less heat to cooling water.** The increased efficiency of higher compression offers relief to cooling systems instead of overloading them.

(5) **Lower exhaust gas temperatures.**

(6) **Lower extreme bearing loads.** At higher speed, where bearing failures occur, the forces of inertia are greater than, and opposed to, the forces of gas pressure in the combustion chamber. By increasing the gas pressure, higher compression decreases the mean load on bearings.

Curves showing the percentage increases in the yearly averages since 1925 for all American passenger cars for engine sizes, horsepower, brake mean effective pressure, r.p.m. at maximum horsepower and horsepower per cubic inch are presented on the opposite page.


Average Values for all American Cars Listed in Trade Publications
Where are we going? Where is your 1933 compression ratio going? Where these curves of averages are going may help answer your question. Here are the average values of all American cars listed in trade publications for seven years. Taking 1925 engines for comparison, the increase for maximum brake horsepower in 1932 is 75%—for horsepower per cubic inch of capacity, 53.5%—for revolutions per minute at maximum brake horsepower, 24.2%—for brake mean effective pressure at maximum brake horsepower, 22.8%, and for displacement only 14.2%.
Max. B.H.P.
H.P. per cu. in.
R.P.M. at Max. B.H.P.
B.M.E.P. at Max. B.H.P.
Displacement
Percent Increase above 1925
0
10
20
30
40
50
60
70
1925
1926
1927
1928
1929
1930
1931
1932

The steady increase in specific power output and brake mean effective pressure indicates the important rôle that compression increases have played in this development of performance gains.

Notice that the curves of engine power and specific power have increased steadily during the last seven years and show no indication of flattening off. Then make your own estimate of how much improvement you need to reach competitive superiority in 1933 for your price class.

1933 cars which are designed to take full advantage of Ethyl Gasoline will offer new-car purchasers the greatest car value. Engineers in the Detroit laboratory of the Ethyl Gasoline Corporation will be glad to cooperate with you in getting maximum benefit from compression increases. Ethyl Gasoline Corporation, New York City.

Ethyl fluid contains lead ©E. G. C. 1932

—THE WILL TO KNOW—

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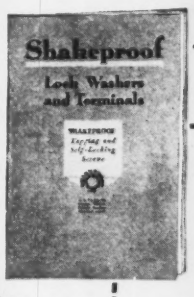

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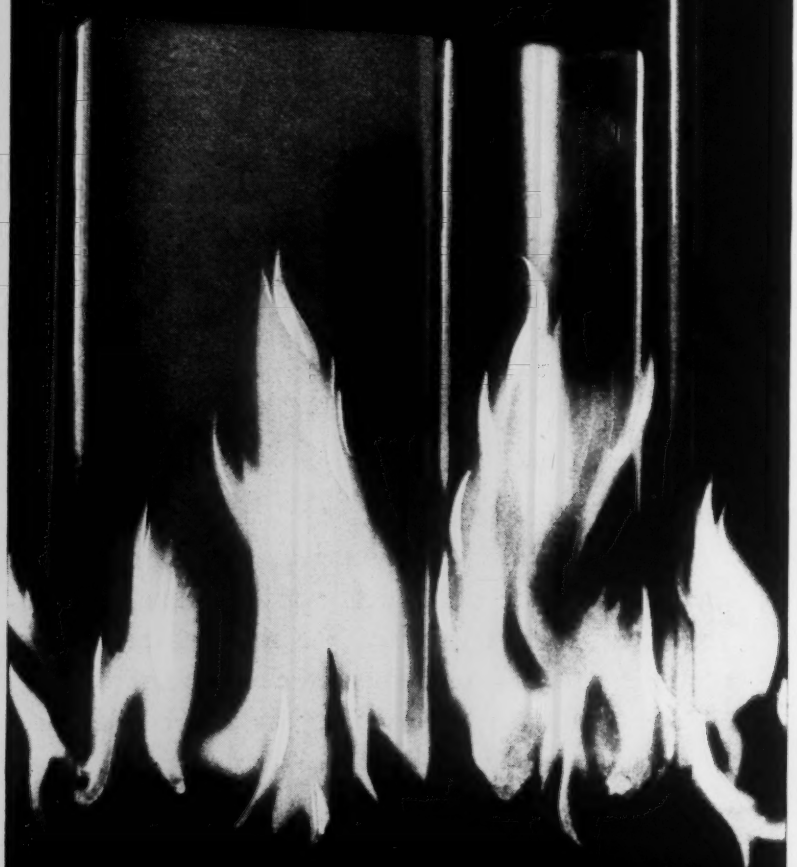

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A.S.M.E. GUIDE TO NATIONAL POWER SHOW

Tenth National Exposition of Power and Mechanical Engineering

Grand Central Palace, New York, N. Y. December 5th to 10th, 1932

THE "A.S.M.E. Guide" to the National Power Show is again presented by MECHANICAL ENGINEERING and contains a "List of Exhibitors" which appears on page 11 and which has been submitted to the Management of the Exposition for final checking. Its accuracy in detail is not guaranteed because of inevitable changes between the date of going to press and the opening of the Show.

In this list the number or numbers of the booths occupied are given and by referring to the floor-space diagrams shown on page 15, a user of the Guide at the Show can readily locate any booth in which he is interested. A.S.M.E. members are especially invited to visit the A.S.M.E. Booth (No. 80) on the main floor near the front entrance, where members of the Staff will be in attendance throughout the Show, and full information regarding A.S.M.E. activities and publications will be available.

The Advisory Committee believes that this Show will have a far-reaching effect in stimulating business in the power and mechanical engineering fields. It is of the opinion that the Exposition will show to the engineering world the faith of the equipment manufacturers in business recovery, which should encourage those who have been marking time.

Most industries have been operating at fractional capacity. The chief items in manufacturing cost, namely materials and labor, vary almost directly with the output. Not so with steam and power services in which the efficiency of production drops off materially with fractionally loaded units. Because of this, improvements in the production of power and steam mean much more to the factory unit-production cost than in prosperous times. Regardless of how rapidly recovery takes place some equipment must be purchased, if for no other reason than that we have all been living close to the ground for the last two or three years and equipment must be replaced. Stern necessity makes it imperative to get the most for the dollar, hence expenditures will be scrutinized to make sure that the investment will produce the lowest net cost. The Exposition will afford an opportunity to make such a selection.

There are many salient features to the Exposition this year, among which the following are outstanding:

(1) The products of three hundred manufacturers of power and mechanical equipment will be shown.

(2) Among the distinctly new things to be seen will be control devices of unique design, including a three-element water-level control; a new type of temperature control; a differential draft-control system; a device for controlling the fuel level in ball mills; and a new type of mechanical steam-flow meter. Many new designs of instruments will be seen, including high-pressure steam gages, fluid meters, condensation meters, recording thermometers and gages for distant pressure recording. Two distinctly new types of expansion joints will be shown for the first time. There will also be on view a superheater especially developed for return-tubular boilers.

(3) The results of research will be reflected in many valves and fittings of alloy steels developed to meet the conditions imposed by the trend toward higher steam pressures and temperatures. Also the progress in welding will be depicted by the display of welding fittings and fusion-welded boiler drums.

(4) Those who have experienced trouble through sliming of condenser tubes will find an exhibit of chlorination methods most interesting.

(5) In the line of fuel burning there will be two new types of oil burners, one of the wide-range mechanical-atomizing type and the other of the steam-atomizing type for burning refinery waste. A new small pulverizer will be seen; also an improved design of multiple-retort stoker in operation.

(6) Among the many other new things are, a device for removing free air from condenser circulating water, a new type of vibration damper, and a hydraulic coupling for use between motors and fans. One manufacturer is showing a thermodynamic motor deriving its power from the surrounding atmosphere. Others are showing surprise features.

(7) An educational display will be that dealing with atmospheric pollution. This will treat the subject from several angles, such as its economic aspect, methods of measurement, effect on the human system, research and progress in abatement. Numerous organizations are cooperating with the Management in this display.

(8) For Saturday morning there is being arranged a specially conducted inspection of the Exposition by upper classmen in several of the nearby universities. This tour will be preceded by addresses from prominent engineers from the fields of mechanical engineering, refrigeration, and heating and ventilation, who will discuss the opportunities in these fields, review present trends in practice and interpret the exhibits.

(9) As it has been two years since the last Exposition this year's display represents the results of two years' accumulative effort in research and development, and many things will be shown here for the first time.

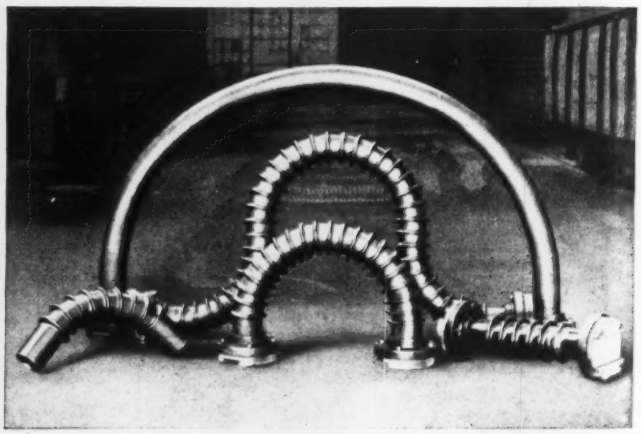
As in previous years, the National Power Show is being held during the same week as the A.S.M.E. Annual Meeting; and a special invitation is extended to all A.S.M.E. members to attend. Tickets of admission can be had without charge at Society Headquarters; and an A.S.M.E. emblem seldom fails to secure for its wearer even more than the usual degree of courteous attention accorded to visitors at booths. In many cases the managers of the booths are A.S.M.E. members themselves; and are glad accordingly, to welcome a visitor with whom they have a common interest.

See Page 11 for List of Exhibitors

See Page 15 for Floor Diagrams

FEATURED AT BOOTH NO. 63—NEW YORK POWER SHOW

New products that reduce space requirements and maintenance cost of Power Piping



KELL-RAPH COPPER PLATED GASKETS

Kell-Raph Gaskets were developed to meet the new operating conditions incident to high pressure and high temperature pipe lines.

Kell-Raph Gaskets—will remain tight under any temperature.

Kell-Raph Gaskets—are easy to install.

Kell-Raph Gaskets—can be re-used several times when fitting changes are necessary.

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Kell-Raph Gaskets—due to their superior design and construction have given excellent service under the most severe operating conditions.

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Kellogg Corrugated Expansion Bends supply the need of greater flexibility in solving the piping problems of high pressure, high temperature generating stations.

Kellogg Corrugated Bends—are four to five times as flexible as plain pipe bends.

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Tenth National Exposition of Power and Mechanical Engineering

LIST *of* EXHIBITORS

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Firms Listed in Bold Face are Advertisers in this Section —See Page 13 for Description of their Exhibits.

10,000 ENGINEERS *can't be wrong!* » » »

There is nothing spectacular about industries acceptance of Republic Flow Meters except its tremendous extent. The conviction of Republic superiority has risen gradually, but surely and substantially.

Today over ten thousand engineers throughout the world have specified Republic Flow Meters in preference to all others. Surely ten thousand engineers cannot be wrong!

Visit Booth No. 6

New York Power Show

for a complete exhibit of instruments

REPUBLIC FLOW METERS COMPANY

2232 Diversey Parkway, Chicago, Ill.

Over 55,000 Republic Flow Meters have been purchased by industry throughout the world

Typical Republic Flow Meter Customers

Company	Republic Meters	Repeat Orders
American Rolling Mills Co.	53	31
American Steel & Wire Co.	210	104
American Sugar Refining Co.	37	14
Associated Oil Co.	45	3
Astoria Light, Heat & Pr. Co.	51	17
A. T. & S. F. R. R. Co.	59	19
Atmospheric Nitrogen Corp.	191	44
Baldwin Locomotive Co.	32	5
Bethlehem Steel Co.	143	57
Brooklyn Union Gas Co.	173	49
Carnegie Steel Co.	352	96
Central Alloy Steel Corp.	41	19
Chevrolet Motor Co.	80	27
City of Chicago	52	15
Chicago By-Prod. Coke Co.	47	16
Chrysler Corp.	32	16
Colorado Fuel & Iron Co.	34	10
Columbia Steel Co.	50	16
Container Corp. of America	56	17
Corn Products Refining Co.	121	38
Crown Willamette Paper Co.	37	15
Cudahy Packing Co.	36	10
Deere & Company	37	14
Detroit City Gas Co.	64	24
Dow Chemical Co.	48	20
E. I. DuPont de Nemours & Co.	217	68
Eastman Kodak Co.	40	30
Firestone Tire & Rubber Co.	46	21
General Aniline Works	102	38
Goodyear Tire & Rubber Co.	96	22
Great Southern Lumber Co.	37	6
H. J. Heinz Co.	43	10
Hercules Powder Co.	58	18
Illinois Maintenance Co.	43	6
Illinois Steel Co.	92	46
International Paper Co.	65	15
Johns-Manville, Inc.	74	25
Jones & Laughlin Steel Co.	36	20
Mathieson Alkali Works	52	19
Minnesota & Ontario Paper Co.	75	12
Missouri-Kansas-Texas R. R.	36	7
Morton Salt Co.	53	6
Fiberboard Products Co.	61	12
National Tube Co.	60	26
New Orleans Public Service Co.	30	3
Penick & Ford	38	10
Peoples Gas Light & Coke Co.	107	41
Procter & Gamble Co.	35	13
Quaker Oats Co.	48	17
Republic Iron & Steel Co.	37	12
St. Lawrence Paper Mills	57	10
Shell Petroleum Corp.	218	90
A. E. Staley Mfg. Co.	53	20
Standard Oil Co.	372	110
Standard Steel Car Co.	38	15
Swift & Co.	127	69
Tennessee Coal, Iron & R. R.	134	70
U. S. Government	121	72
Vacuum Oil Co.	60	26
West Pennsylvania Power Co.	48	5
West Virginia Pulp & Paper Co.	188	78
Western Electric Co.	41	23
Wheeling Steel Corp.	89	36
Wisconsin Steel Works	46	20
Youngstown Sheet & Tube Co.	216	81

Tenth National Exposition of Power and Mechanical Engineering

EXHIBITS of ADVERTISERS in this Section

See Page 11 for List of Exhibitors and Page 15 for Floor Diagrams

Booth

Air Preheater Corp'n 25
40 East 34th St., New York, N. Y.
See Advertisement on Page 19

Exhibit will consist of a section of a Ljungstrom Preheater showing the construction of the heating surface and its general arrangement.
Those in attendance at the exhibit will be: H. S. Colby, President, and E. Creutz, of the Engineering Department.

American Air Filter Co. (Inc.) 427, 428
234 Central Ave., Louisville, Ky.
See Advertisement on Page 14

The central feature of their exhibit will be the TURBO-CLONE, a recent development for controlling process dust. Will have a No. 4 Turbo-Clone in operation with the exhaust connected to a 5-dash Pocket Airmat Dust Box. The hopper of the Turbo-Clone will be all glass so as to make any demonstrations as effective as possible. Will have engineers available for conducting tests on any dust samples submitted by visitors and show what it will actually accomplish with their dust problem. In addition will display their Multi-Panel Automatic Air Filter, the new No. 5 N. V. Airmat unit and the Airgard Electric Ventilator.

Bartlett-Hayward Co. 528
200 Scott St., Baltimore, Md.
See Advertisement on Page 23

In this exhibit will be shown sectionalized mounted models and photographs of various types of Fasts' Flexible Couplings. Particular attention will be called to the design of this all-metal double engagement, positively lubricated flexible coupling which takes care of misalignment and allows free end float without making use of any flexible materials.

Boston Gear Works Sales Co. (Inc.) 326-331
North Quincy, Mass.
See Advertisement on Page 16

Will exhibit representative types of Boston Gear stock products of every description, consisting of Gears, Speed Reducers, Reeves Variable Speed Transmission, Renold-Boston and Duckworth Boston Inverted Tooth and Roller Chain Drives, Doehler-Boston Die-Cast Stock Gears, Curtis Universal Joints, "Nice" Ball Bearings, light transmission parts, etc. Exhibit will include a movable display of a Boston Motorized Speed Reducer.

Detroit Stoker Co. 73
General Motors Bldg., Detroit, Mich.
See Advertisement on Page 17

The feature of the exhibit will be a full sized Detroit Multiple Retort Stoker in operation. It is offered as an outstanding contribution to the economical burning of coal. It is an inclined fuel bed stoker with effective underfeed action. A continuous movement of the fuel under full mechanical control. The ease with which separate adjustments of coal feed and the distribution within the furnace will be demonstrated, while the stoker is operating. For large boilers to be operated continuously at extreme ratings, it is built in varying widths and lengths which makes it applicable to practically all furnace sizes. Complete information and literature will be available regarding this and other types of Detroit Stokers.

Foster Engineering Co. 84
109 Monroe St., Newark, N. J.
See Advertisement on Page 16

Will exhibit new types of Pressure Regulators, Pump Governors, Air-Operated Pressure Reducing Regulator, Pressure Control Valve, Damper Regulator and Class G 2 Type Pressure Reducing Regulator, of stainless steel, for high pressures and temperatures. Also, valve internal parts of stainless and forged steel, conducive to the durability of Foster Valves. Engineers are invited to submit their Automatic Valve Problems.

General Electric Co. 4, 5
Schenectady, N. Y.
See Advertisement on Page 20

Gear-motors and Control Equipment will be featured in the exhibit. Other equipment to be displayed will include Compressors, improved arc welding equipment, and welding electrodes, a noise meter, and a display cabinet of heating units.
Representatives at the show will include T. H. Reeves, J. J. Curtin, H. V. Crawford, P. A. McFerney, E. Vom Steeg.

Kellogg, M. W., Co. 63
225 Broadway, New York, N. Y.
See Advertisement on Page 10

Featuring two new products which reduce space requirements and maintenance cost of Power Piping. Kell-Raph Copper Plated Gaskets and Kellogg Corrugated Expansion Bends. Kell-Raph Gaskets were developed to meet the new operating conditions incident to high pressure and high temperature pipe lines. Kellogg Corrugated Expansion Bends supply the need of greater flexibility in solving the piping problems of the high pressure, high temperature generating stations. Will also exhibit various products manufactured by the forge and hammer lap welded process, as well as various types of flanges, gaskets and joints.

Booth

Linde Air Products Co. 3
205 East 42nd St., New York, N. Y.
See Advertisement on Page 18

Featuring their latest development which is a complete portable welding and cutting outfit. Also showing various items from their line of welding equipment, which covers all welding and cutting problems in the Power and Mechanical Engineering fields. A staff of engineers will be on hand at all times to answer questions pertinent to welding and cutting.

Norma-Hoffmann Bearings Corp'n 263, 264
Stamford, Conn.
See Advertisement on Page 24

Will display a complete line of sample ball, roller and thrust bearings. This year they are featuring particularly their self-aligning bearings, their new LUP pillow blocks and their recently announced CD double angular contact Duplex type ball bearings.
The representatives who will be in attendance at the booth are as follows: O. P. Wilson, Vice-President; H. J. Ritter, Sales Manager; D. E. Batesole, Asst. Engineering Manager; F. W. Mesinger, N. Y. District Manager, T. E. Rounds, Engineering Department, R. Gannett, E. W. Lawrence, and R. V. Donnelly, N. Y. Sales Representatives.

Parker Appliance Co. 86-88
10320 Berea Road, Cleveland, Ohio
See Advertisement on Page 16

Exhibit will feature their standard line of brass, bronze, steel, nickel, monel metal, aluminum alloy and stainless steel fittings, valves, draft meter manifolds, and similar power plant plumbing products, together with tube benders, flaring tools, and fabricating units. Will also feature new line of PARKER "INNER-SEAL" Soldered Fittings for use in low pressure and normal temperature installations. In their exhibit will be an extensive line of tubing in brass, copper, steel, stainless steel, nickel, monel metal, and aluminum alloy. The PARKER Line meets every power plant requirement for smaller sizes of plumbing and instrument piping. PARKER Products are used extensively in railroad steam locomotives, in Diesel engines, marine installations and wherever high pressures and temperatures or severe corrosive conditions are encountered.

Republic Flow Meters Co. 6
2232 Diversey Parkway, Chicago, Ill.
See Advertisement on Page 12

The exhibit will feature the Republic Centralized Metering System—a system of metering which will permit the centralization of all essential records on one panel centrally located irrespective of the distance from the measuring point. There will also be exhibited, miniature reproductions of Republic Centralized Metering Systems, designed and built for the City of Hamilton, Ohio—Eli Lilly & Company—Bogalusa Paper Company—the Kroger Grocery & Baking Company. A special feature of the exhibit will be the new Republic Multiple Recording System, which will produce coordinate records of flows, temperatures, pressures, vacuums, CO_2 percentages, etc., on a single, evenly divided strip chart, and thereby show operating conditions at a glance. Republic CO_2 Meters of both the mechanical and electrical recording and indicating type will be on display in operation. The new mechanical CO_2 Indicator will be on display for the first time. The exhibit will also feature the standard line of Republic Flow Meters, Thermometers, Draft Gages, Liquid Levels, and Pyrometers.

S K F Industries (Inc.) 223, 224
40 East 34th St., New York, N. Y.
See Advertisement on Page 21

A full range of S K F Ball and Roller Bearings and S K F Pillow Blocks, from the smallest to the largest, will be the main feature of attraction at their exhibit. Interesting devices demonstrating the anti-friction qualities of S K F Bearings will also be on display. Those in attendance at the exhibit will include: R. H. De Mott, F. E. Ericson, J. D. Williamson, G. E. Allen, C. A. Decker, J. C. Gayler, W. B. Ashland, H. Wood, C. J. Priebe, B. F. Davis, S. A. Miller. Headquarters during the show will be maintained at the Shelton Hotel.

Simplex Valve & Meter Co. 92
6753 Upland St., Philadelphia, Pa.
See Advertisement on Page 22

Exhibit will include a panel, with Simplex standard indicating, recording, totalizing meter mounted thereon; said meter being for boiler feed, or condensate measurement. A new feature of this meter will be the addition of an Elinco Transmitting Motor unit, which permits the sending of the flow electrically to an Indicator, Recorder or Totalizer, or a complete Indicating, Recording, Totalizing Instrument. The panel will also have mounted thereon an Indicating dial, which will receive the flow from the Meter. One of the outstanding installations of this nature, while not in the power field, has to do with the large meter in the Catskill Aqueduct System at Shaft No. 2, where we transmit the flow electrically from a Simplex Meter Register to a Recorder.
W. K. Sowdon, their New York Representative, will be in charge of the booth, and Mr. Jones, Mr. Harveson, and Mr. Smith, of Philadelphia, will be at the show at various times.

TURBO-CLONE

Dynamic Precipitator

Combines Blower and Dust Separator *in a* Single Unit

Here is a revolutionary development in the conveying and collecting of all forms of process dust.

TURBO-CLONE saves valuable space because it performs the whole process of separation at or near the source of the dust. TURBO-CLONE saves installation expense because it eliminates costly piping and ducts. TURBO-CLONE sets new standards of efficiency because it separates the dust *dynamically* instead of statically by means of an impeller with blades of unusual shape that move the air and separate the dust at the same time. TURBO-CLONE materially reduces power costs because of its higher efficiency and unique principles of construction.

TURBO-CLONE is already in use in a number of industries where dust—whether valuable or objectionable—must be collected. Its performance is exciting enthusiastic praise. If you have a dust problem you should know more about this revolutionary development. Send for literature and complete engineering data.

AMERICAN AIR FILTER CO., *Inc.*
DUST CONTROL DIVISION
234 CENTRAL AVENUE LOUISVILLE, KY.
In Canada, MIDWEST CANADA LTD., Montreal, P. Q.

MECHANICAL ENGINEERS:

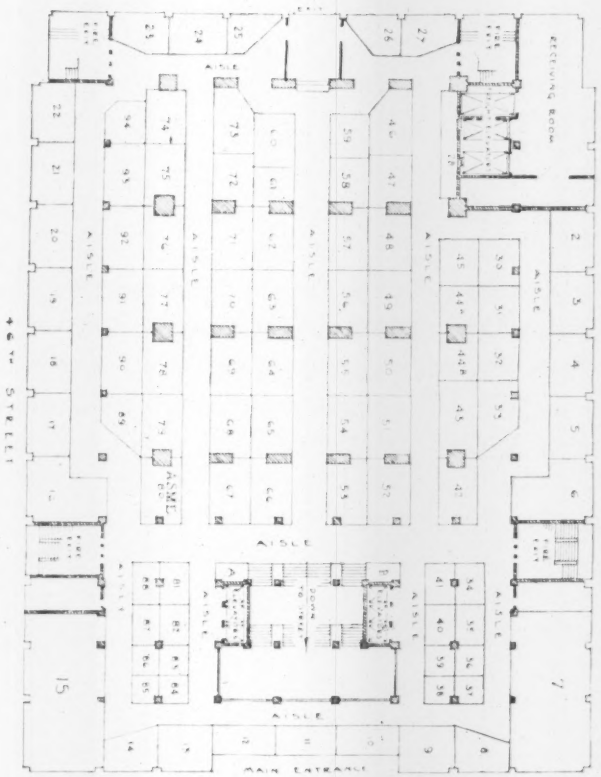
TURBO-CLONE will be on display at the New York Power Show, booths 427 and 428, December 5th to 10th. Our engineers will be prepared to make tests at any time during the show. You are invited to submit dust samples (two pounds minimum) to demonstrate the efficiency of the TURBO-CLONE on your particular dust problem.

FLOOR DIAGRAMS

Tenth National Exposition Of Power and Mechanical Engineering

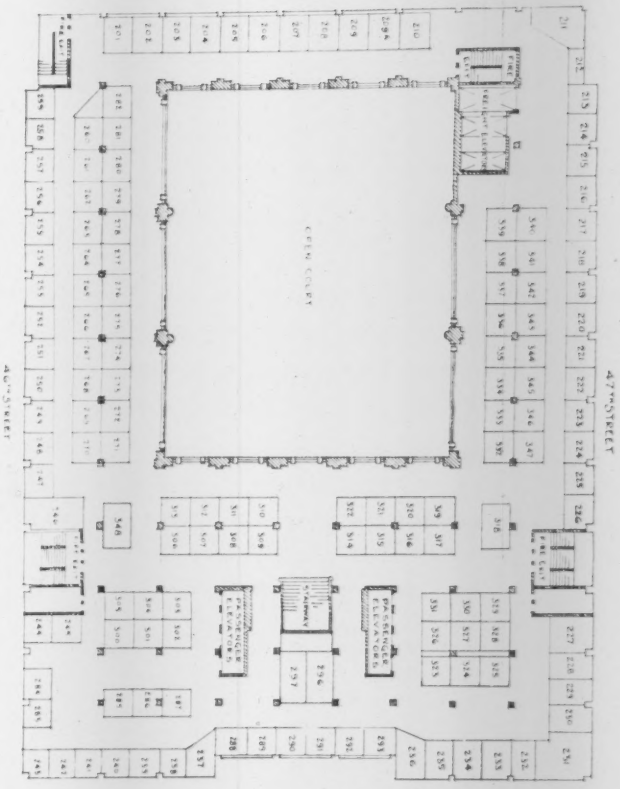
December 5th to 10th, 1932 **Grand Central Palace, New York, N. Y.**

FIRST FLOOR



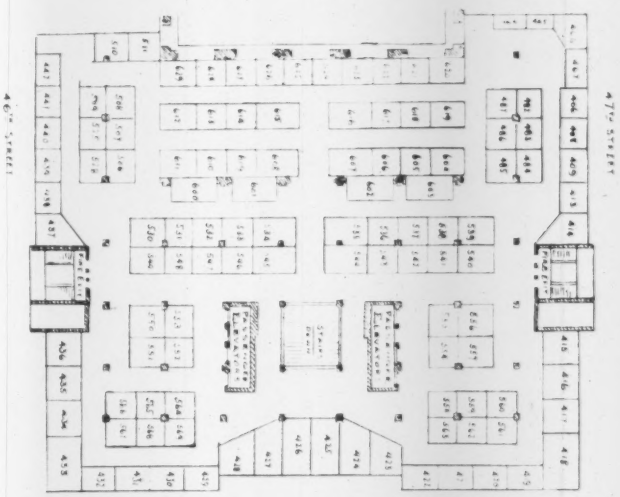
BOOTHS NOS. 1-95

SECOND FLOOR



BOOTHS NOS. 200-348

THIRD FLOOR



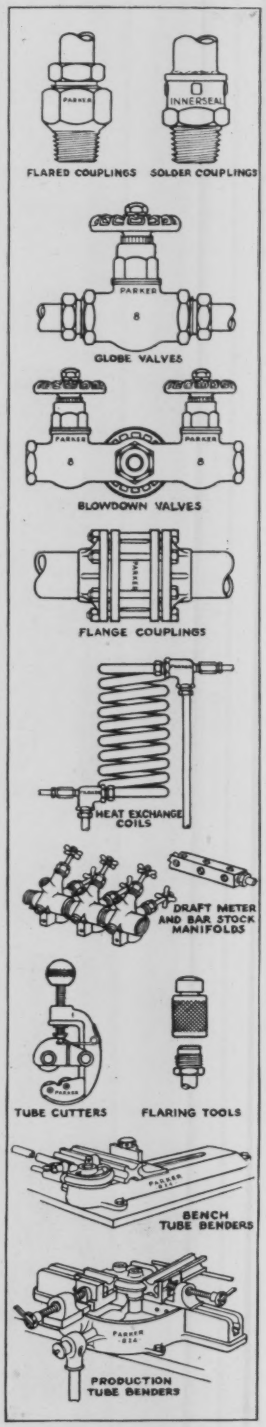
BOOTHS NOS. 401-629

See page 9 for Story of the Show

See Page 11 for List of Exhibitors

PARKER

THREADLESS PLUMBING



Brass—Bronze—Carbon Steel—Stainless Steel—Monel Metal—Aluminum and Aluminum Alloys—Pure Nickel or Iron—Fittings, Valves and Seamless Tubing of every description is listed in our literature, carried in stock and displayed at

BOOTHS
86-87-88
Ground Floor of the Tenth Annual Power Show

PARKER SEAMLESS TUBE—THREADLESS PLUMBING is standard practice in modern power plants—the PARKER LINE meets every pressure, temperature or corrosion requirement.

Complete fabricating and make-up equipment facilitates installation, and assures remarkable economies.

VISIT OUR DISPLAY

(Send for Literature)

PARKER APPLIANCE CO.
Dept. B-3
Cleveland,
10320 Berea Road
Ohio, U.S.A.

FOSTER ENGINEERING CO.

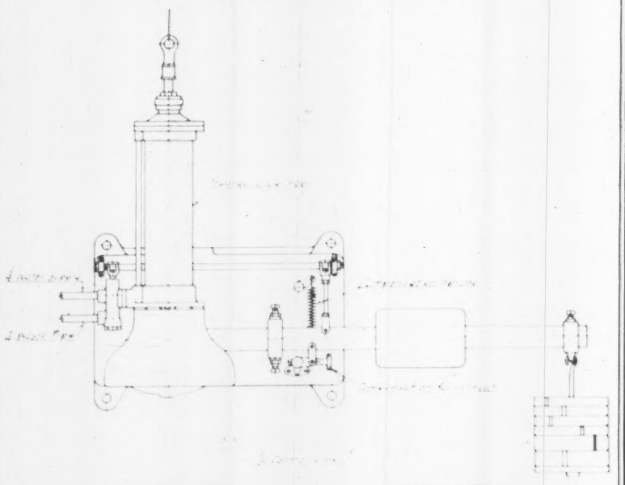
MAIN OFFICE AND FACTORY—NEWARK, N. J.

MANUFACTURERS

Automatic Valve Specialties

A New Addition to the Foster Line

DAMPER REGULATOR for controlling DRAFT SYSTEMS. BALANCED VALVES and other apparatus



ACCURATE! RELIABLE!

Will be on Exhibition at the
"POWER SHOW" Dec. 5-10, BOOTH 84

"BOSTON"

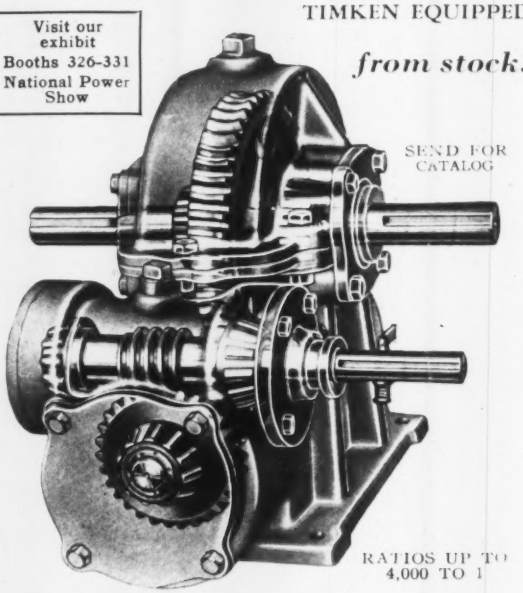
SPEED REDUCERS

TIMKEN EQUIPPED

from stock!

Visit our exhibit
Booths 326-331
National Power Show

SEND FOR CATALOG



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BOSTON GEAR WORKS SALES CO., North Quincy, Mass.
BOSTON NEW YORK PHILADELPHIA CLEVELAND CHICAGO
SERVICE STATIONS FROM COAST TO COAST

BOSTON GEARS

See It at the Power Show (Booth 73 MAIN FLOOR)

The Latest Development in the Economical Burning of Coal

In Booth 73 on the Main Floor at the New York Power Show, see the Detroit Multiple Retort Stoker —a stoker that is setting new standards in stoker performance.

Here are a few of its features: (1) Inclined fuel bed with complete underfeed action, (2) closely spaced square retorts have large capacity, (3) correct air distribution is insured by zoning of air and variation in tuyere openings, (4) extension moving grates, (5) individual adjustment of coal feed to each retort, and (6) adjustment of coal distribution in each retort is easily made while stoker is in operation.

If you do not attend the New York Power Show, get in touch with our nearest office for a copy of the new bulletin that completely illustrates and describes the Detroit Multiple Retort Stoker. Ask for Bulletin **128**

DETROIT STOKER COMPANY

Sales and Engineering Offices:

Third Floor, General Motors Bldg., Detroit, Mich.

Works at Monroe, Mich. . . . District Offices in Principal Cities

Built in Canada for Canadian Trade

MODERNIZE AND ECONOMIZE WITH

DETROIT STOKERS

WANTED:

THE MANUFACTURER of these strip steel megaphone rims wanted a perfectly flush joint strong enough to withstand cold die-pressing, and quick and inexpensive to produce.

A Linde representative suggested oxy-acetylene welding, with the type of jig shown above. The megaphone maker tried it—and got a joint that met every requirement.

How about your product? Is it light enough now, and strong enough? Easy enough to produce and finish? Profitable enough to make a cut in production costs needless?

If it isn't, oxwelding offers you one good way to get the results you want. But before you commit yourself to welding, get all the facts from The Linde Air Products Company, whose 25 years' experience in applying welding to every type of product may save you time and money.

Or even if welding doesn't seem to be the process you are after, get in touch with Linde anyhow. Oxwelding is being used for so many things that no one man can know them all. Maybe right now it is doing some job very similar to yours. Let Linde advise you frankly.

A card or a call to our nearest District Office will bring you complete information, without obligation. Mail the card or make the call *now*, and get the newest and best data on production welding.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

126 Producing Plants UCC 627 Warehouse Stocks

IN CANADA, DOMINION OXYGEN COMPANY, LTD., TORONTO

District Offices

Atlanta	Detroit	New York
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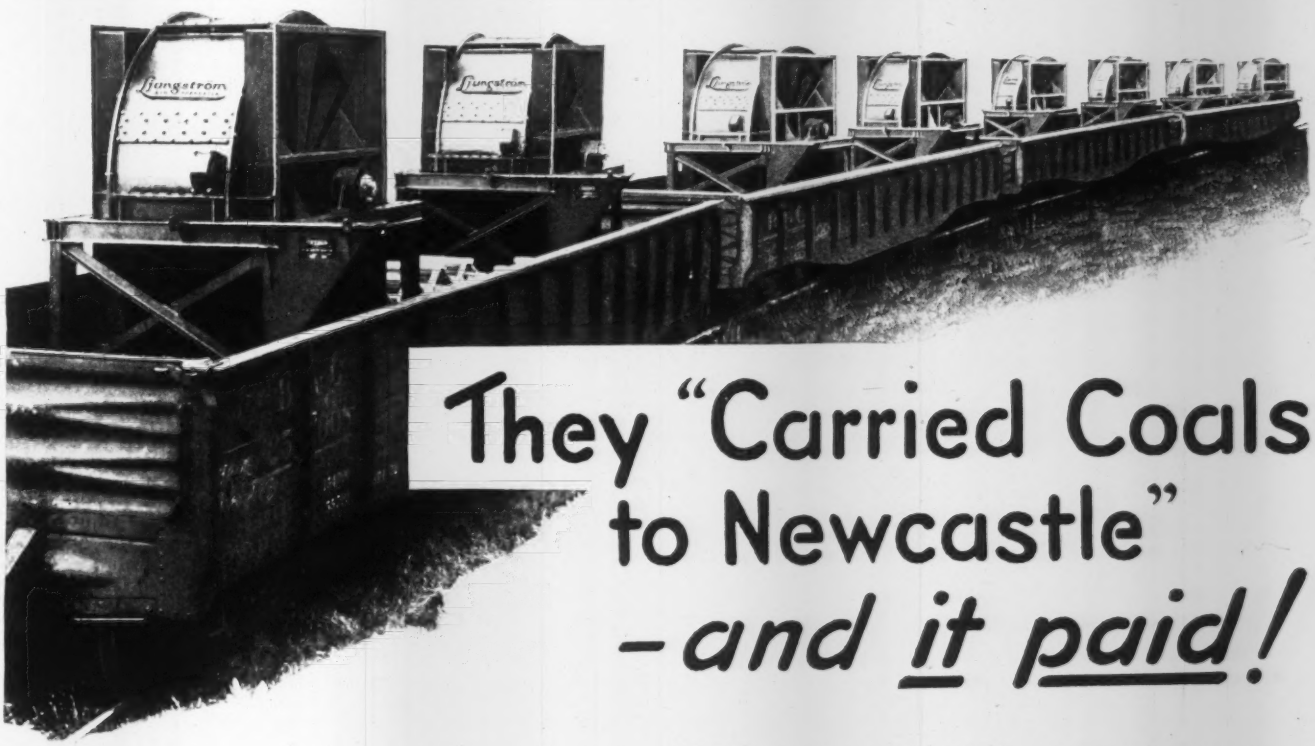


They "Carried Coals to Newcastle" —and it paid!

AIR Preheaters are usually installed to effect a fuel saving which averages around 10 per cent

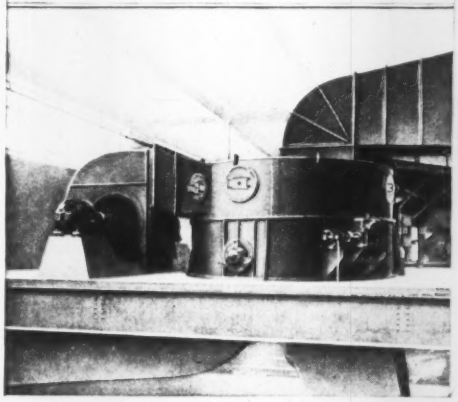
yet a large oil refinery burning almost costless residue has just placed three more large Ljungstrom Preheaters in service after three years' experience with a previous installation.

In making their latest purchase, the refinery owners realized that in the proposed new boilers, the heating surface exposed to the furnace generated most of the steam—that very little came from the colder end. They therefore cut off this latter less efficient surface—reduced the boiler size from 1400 hp. to 1040 hp. at a great saving in boiler cost—sent the gas to the flue at 800 deg.—and used Ljungstrom Preheaters for reduction to the final 320 deg., a temperature below that of the steam and unattainable with a boiler unit alone. Sending to the furnace the 650-deg. air so obtained then gave the same steaming capacity as obtainable from the 1400-hp. boilers fired with cold combustion air, but with better overall efficiency and from a lower plant investment.

Ljungstrom Preheater capacity costs only about half as much as the cold-end boiler surface it displaces, does its work at only a few ounces pressure and in addition to reducing fixed charges, effects a worth-while annual saving in fuel and its handling even with the low-cost residue burned in the above refinery.

Write for this booklet or get a copy at the Power Show

SOMETHING *to* THINK ABOUT before buying the next boiler



Even though you get fuel "at Newcastle cost," reduced plant investment can still make Ljungstrom Preheaters highly profitable—and with normal or high fuel costs, the fuel saving alone will yield a bigger annual net cash return than obtainable from any other equipment in your plant. Think this over before buying your next boiler—and let our Engineers give you guaranteed performance figures.

Over 800,000 boiler hp. in service in the U. S. A.

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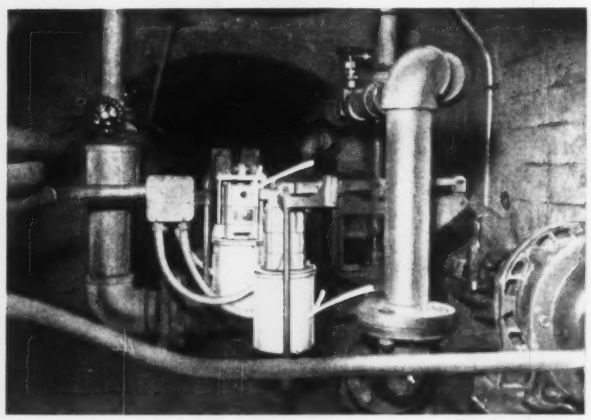
CONTINUOUS REGENERATIVE COUNTERFLOW

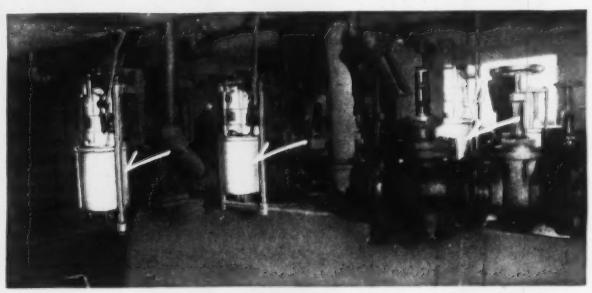
TO KEEP UP . . . . . CHECK UP . . .

THRUSTOR Valves Solve Many Problems

A GENERAL ELECTRIC Thrustor valve solved the problem of automatic, accurate control of water for each batch of concrete according to weight—solved it to "our complete satisfaction" wrote the customer, and "this valve has functioned perfectly." A leather goods manufacturer writes: "The closing of the Thrustor valve, while being positive, is accomplished without sudden jar. We consider this unit to be a distinct improvement over former types of mechanical valve operation." Statements from users in a wide variety of industries attest the ability of Thrustor valves in solving difficult valving problems.



Two Thrustor valves doing a difficult job under an electric fountain



Line-up of Thrustor valves—a typical installation

To keep up — check up your present valves. In this list—which is representative of scores of applications—check those about which you would like complete information:

- ☐ Admitting and exhausting air
- ☐ Maintaining temperature in open tanks
- ☐ Maintaining water levels
- ☐ Introducing molasses or other heavy liquids
- ☐ Control of water flow (or other liquids)
- ☐ Controlling weight of materials
- ☐ Remote control
- ☐ .....
- ☐ .....

Address your inquiry to the nearest G-E office, or General Electric Company, Schenectady, N. Y. Ask for a copy of publication GES-848, "Why Thrustor Valves?"

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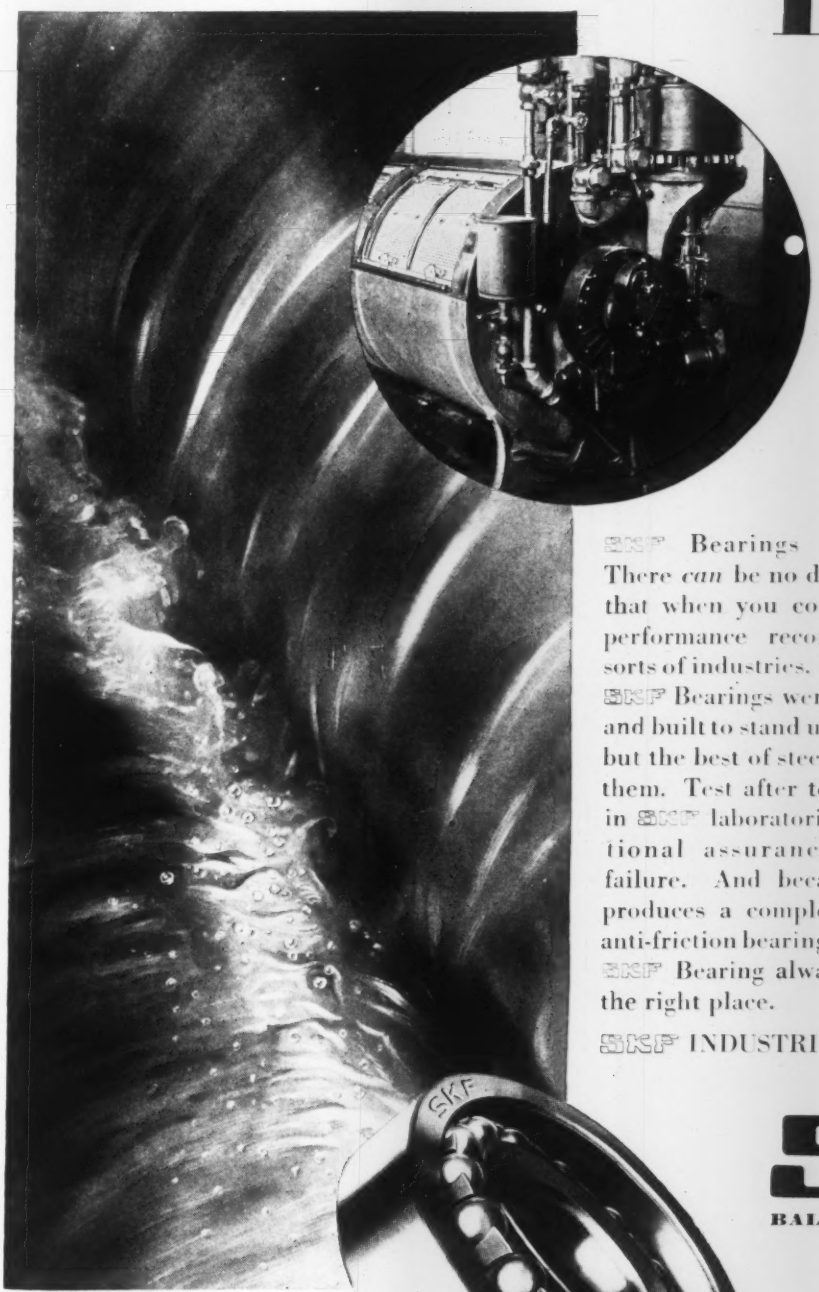

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SKF Bearings stand up. There *can* be no doubt about that when you consult their performance records in all sorts of industries. But then... SKF Bearings were designed and built to stand up. Nothing but the best of steels goes into them. Test after test is made in SKF laboratories as additional assurance against failure. And because SKF produces a complete line of anti-friction bearings, the right SKF Bearing always goes in the right place.

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Above: SKF-Equipped Henrici washer installed June 8, 1914 in the laundry of St. Elizabeth's Hospital, Brighton, Massachusetts, where it was in operation from six to eight hours a day, six days a week for eighteen years.

* * *

No manufacturer can afford to take a chance on the performance of his product by taking a chance on the performance of the bearings he selects for it.

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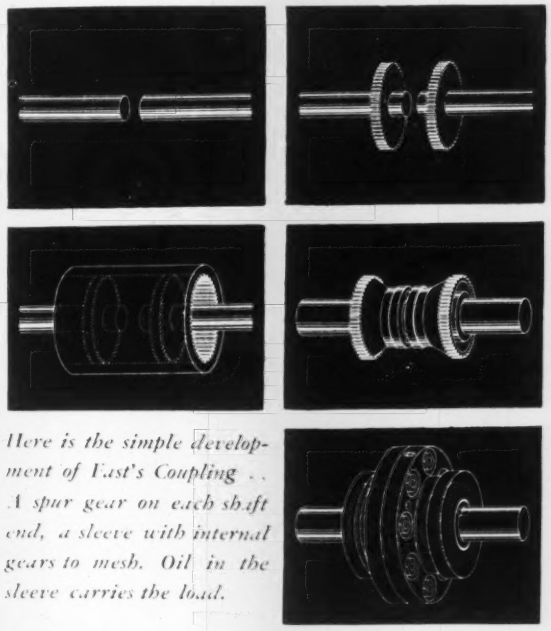
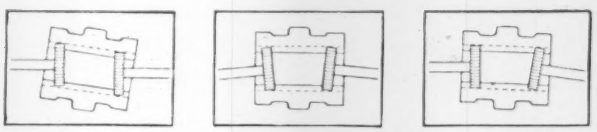


Here is the simple development of Fast's Coupling .. A spur gear on each shaft end, a sleeve with internal gears to mesh. Oil in the sleeve carries the load.



Exaggerated diagrams show how all forms of misalignment are compensated for between the lubricated faces of the gear teeth. Note how entire assembly rotates as a unit.

You Can Be Through with Coupling Shut-Downs Specify FAST'S

YOUR experience will tell you that almost every coupling shut-down in your plant has been caused by the failure or breaking of a flexible pin, grid, disc, washer, or spring. Suppose these materials were done away with? Suppose the coupling was made of non-flexible materials—at all points? Wouldn't coupling shut-downs cease to plague you, cease to lose money for your plant?

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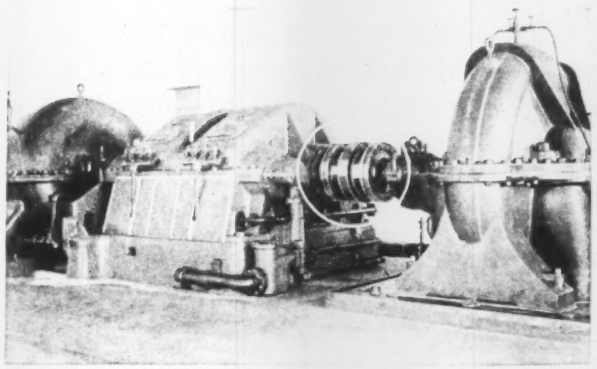

Fast's Self-Aligning Coupling on Turbine Driven Pump at Metropolitan Utilities District, Omaha, Nebraska

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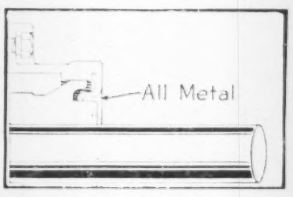

Not a single flexible material, not a single rubber or felt washer is used in Fast's Coupling. All metal to metal contact prevents dust, grit, fumes, or moisture from getting into the working assembly. Due to this exclusive principle, Fast's Couplings never cause shut-downs because of internal wear due to foreign substances.

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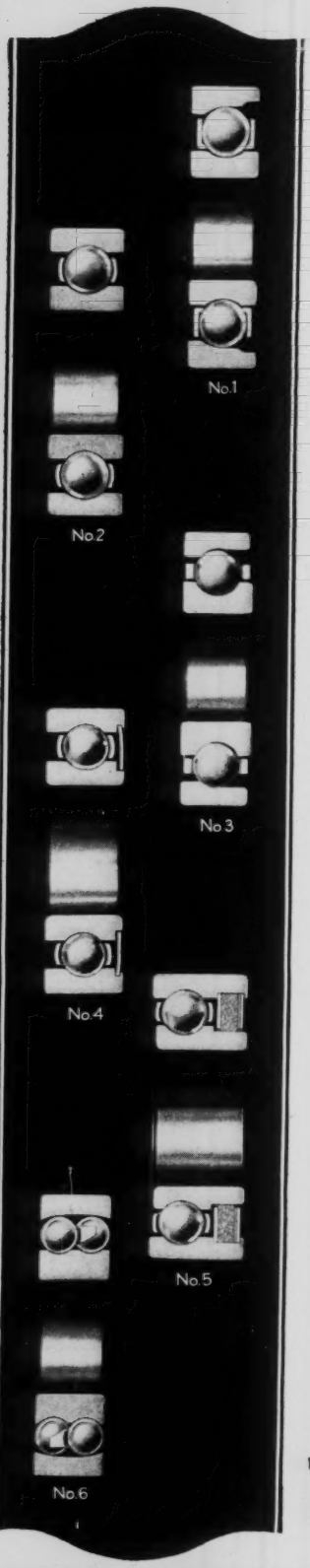

This is the objective of every executive, engineer and designer; and the performance of the bearings in a production machine is a vital factor in keeping costs down. * * * * But, in comparing bearings, look beyond first cost—look to the ultimate cost over a period of years. Let proved performance point the way to your decision. * * * * For over 20 years, in every field of industry, Norma-Hoffmann **PRECISION** Bearings have been making distinguished records for unfailing dependability—records which command the confidence of those who seek the lower production costs that come with the use of better bearings.

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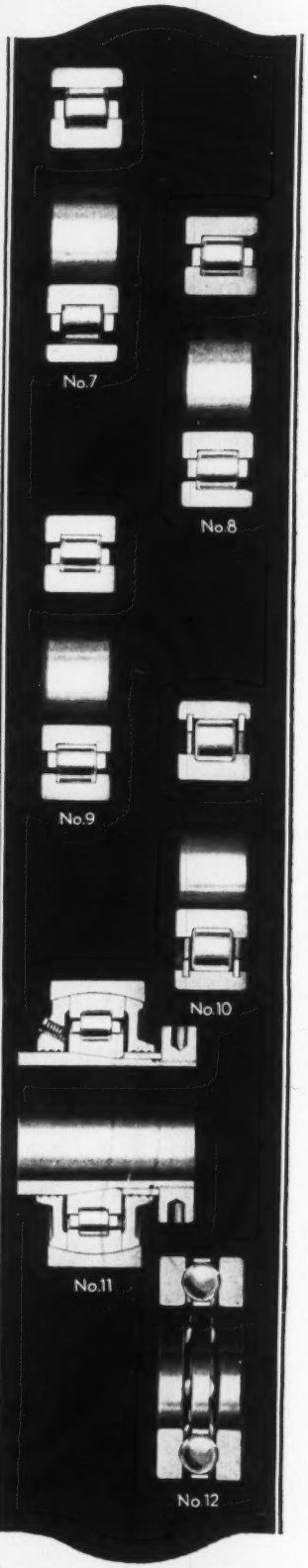

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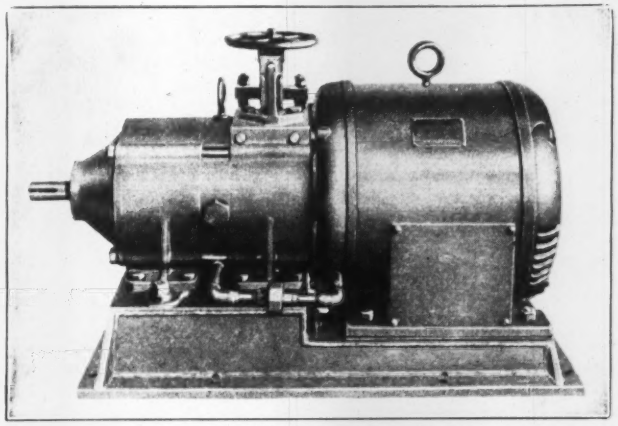

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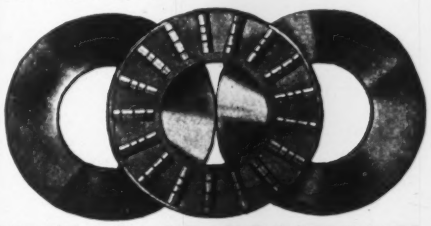

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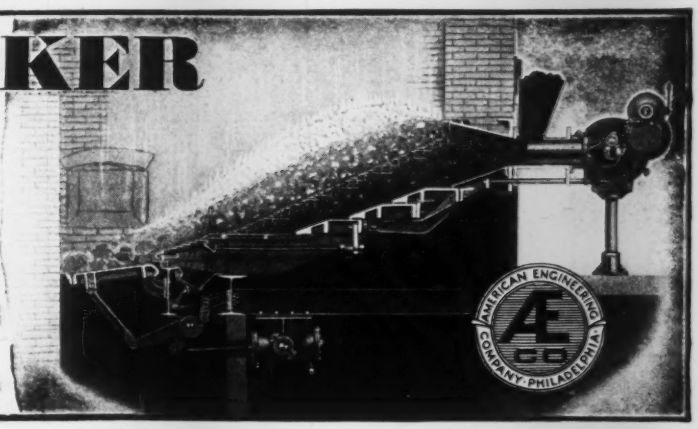

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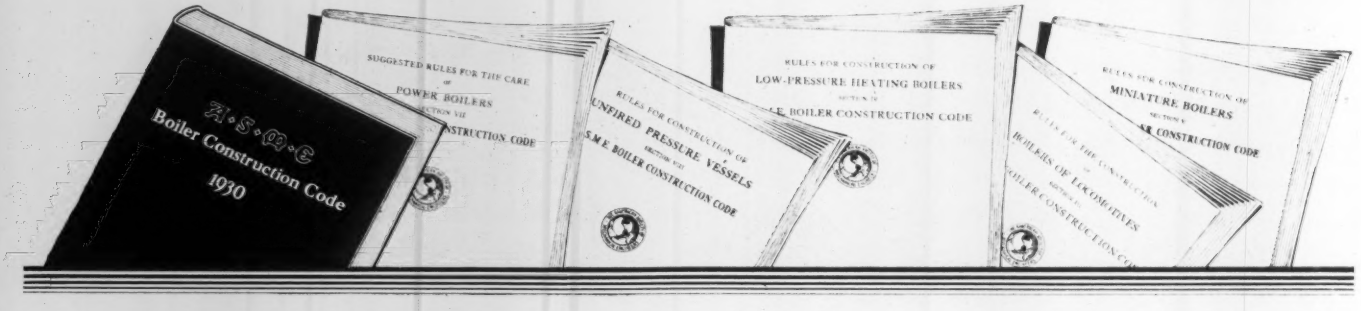
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1930
SUGGESTED RULES FOR THE CARE OF POWER BOILERS
RULES FOR CONSTRUCTION OF UNFIRED PRESSURE VESSELS
RULES FOR CONSTRUCTION OF LOW-PRESSURE HEATING BOILERS
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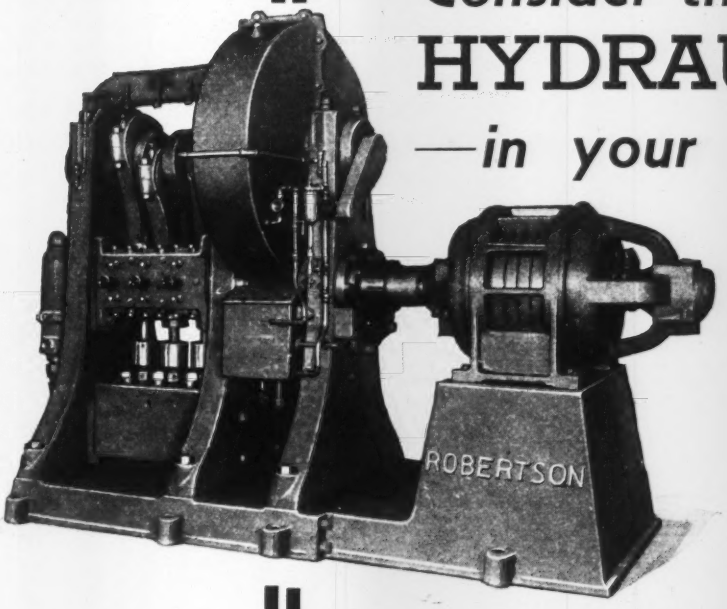

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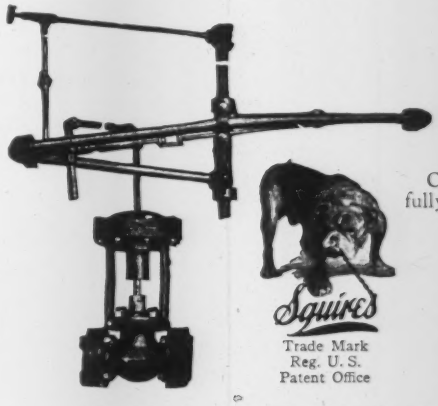

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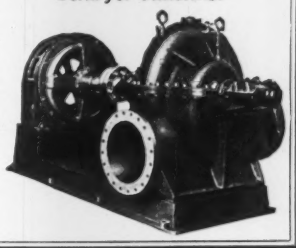

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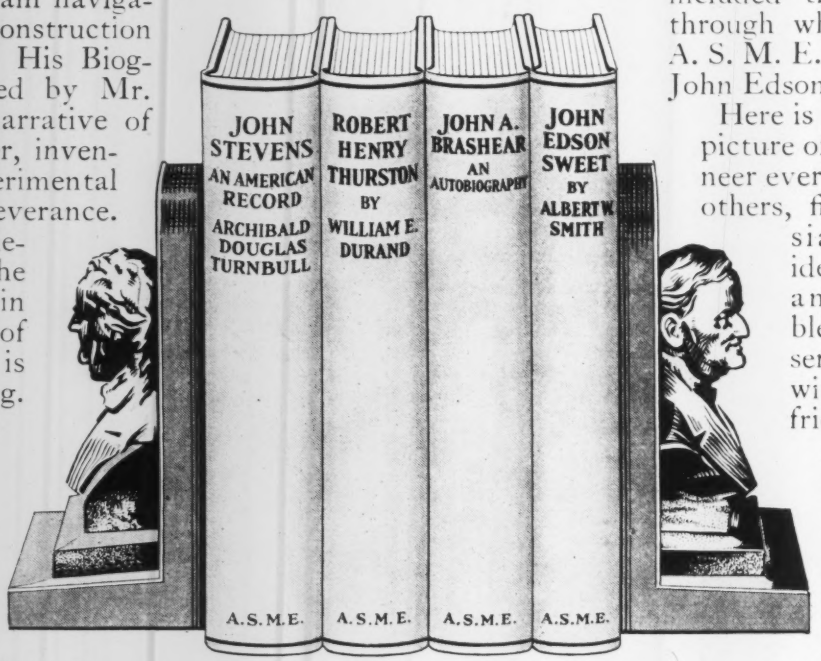

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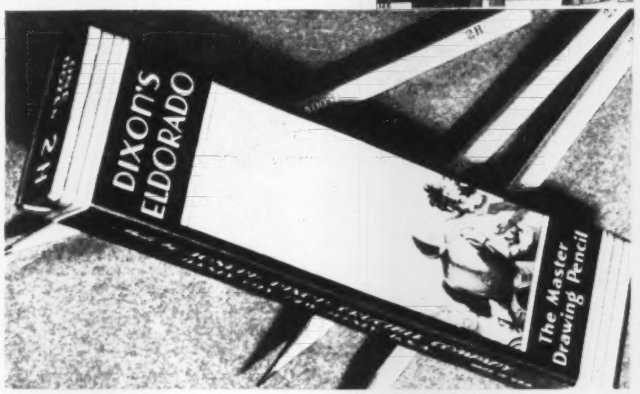

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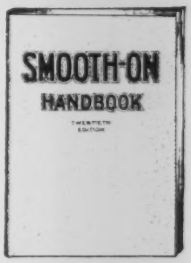

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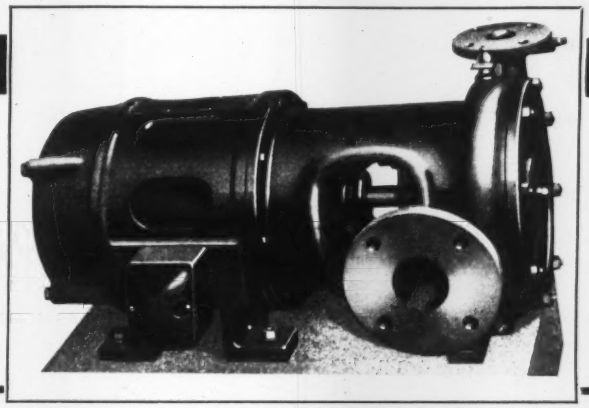

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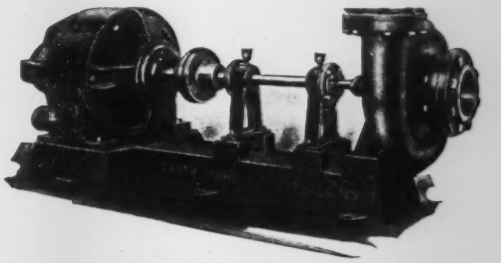

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When seeking information about a given specialty, for example, regarding a Steam Power Plant, look under "POWER PLANTS, STEAM" and under this heading and its subheadings are listed those specializing in the design, location, supervision, layout, test, etc., of such a project. Select one or more names and refer to the Alphabetical List in the center of the page for addresses.

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The library is open from 9 a.m. to 10 p.m., with trained librarians in constant attendance. Its resources are at the service of the engineering and scientific public.

A light forever burning . . .
A voice that is never stilled

NIGHT comes on and spreads a blanket of darkness upon sleeping cities and towns. Here and there a lone policeman. In the distance a clock tolling the hour.

In the dark silence of the night, there is one light forever burning . . . one voice that is never stilled. That light is the light in the telephone exchange. That voice is the voice of your telephone. A city without telephones would be a city afraid—a city of dread.

For the telephone brings security. Its very presence gives a feeling of safety and nearness to everything. In times of stress and sudden need it has a value beyond price. In the many business and social activities of a busy day it is almost indispensable.

The wonder of the telephone is not the instrument itself but the system of which it is the symbol . . . the system which links your own telephone with any one of eighteen million others in the United States and thirteen millions in other countries.

Every time you use your telephone you have at your command some part of a country-wide network of wires and equipment, and as many as you need of a great army of specialists in communication.

There are few, if any, aids to modern living that yield so much in safety, convenience and achievement as your telephone.

AMERICAN TELEPHONE AND TELEGRAPH COMPANY

Alphabetical List of Advertisers

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This list gives the names of all firms advertising in MECHANICAL ENGINEERING during 1932 including this issue. Where page number is omitted after a name, it shows that the advertiser appeared in preceding issues. The asterisk (*) before a name indicates that catalog data of that firm appears in MECHANICAL CATALOG, 1932–33 edition.

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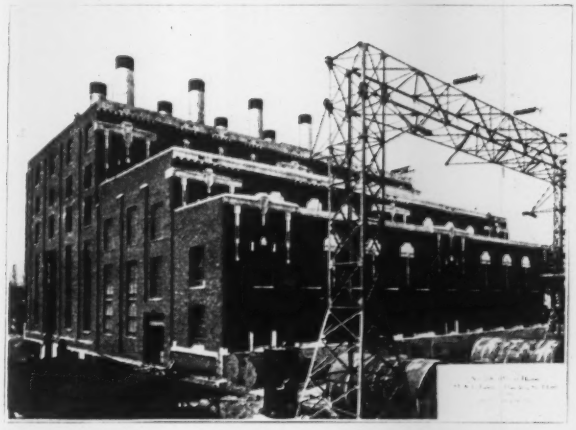
Advertising Forms of MECHANICAL ENGINEERING close on the sixth of the month preceding date of issue

Space reservations, copy and cuts for advertisements to appear in the January issue should reach us not later than December sixth.

SPRINGFIELD BOILERS & WATER WALLS

SECTIONAL —— ALL STEEL



8-1181 Hp. Springfield Boilers Installed in Indianapolis, Ind.

Do Repeat Orders Signify Complete Satisfaction?

MANAGEMENT & ENGINEERING CORP'N,
Chicago, Illinois.

Have favored us AGAIN and AGAIN with orders for SPRINGFIELD units, installing a total of 22804 boiler horsepower in EIGHT of their steam generating stations at EIGHT different times.

There must be a reason for this continued confidence. INVESTIGATE NOW.

Many other leading utility plants obtain their power from SPRINGFIELD units.

SPRINGFIELD UNITS ARE BUILT IN ALL SIZES AND FOR ALL PRESSURES.

Write for Catalogue

REPEAT ORDERS CONSTITUTE THE LARGEST PART OF OUR BUSINESS

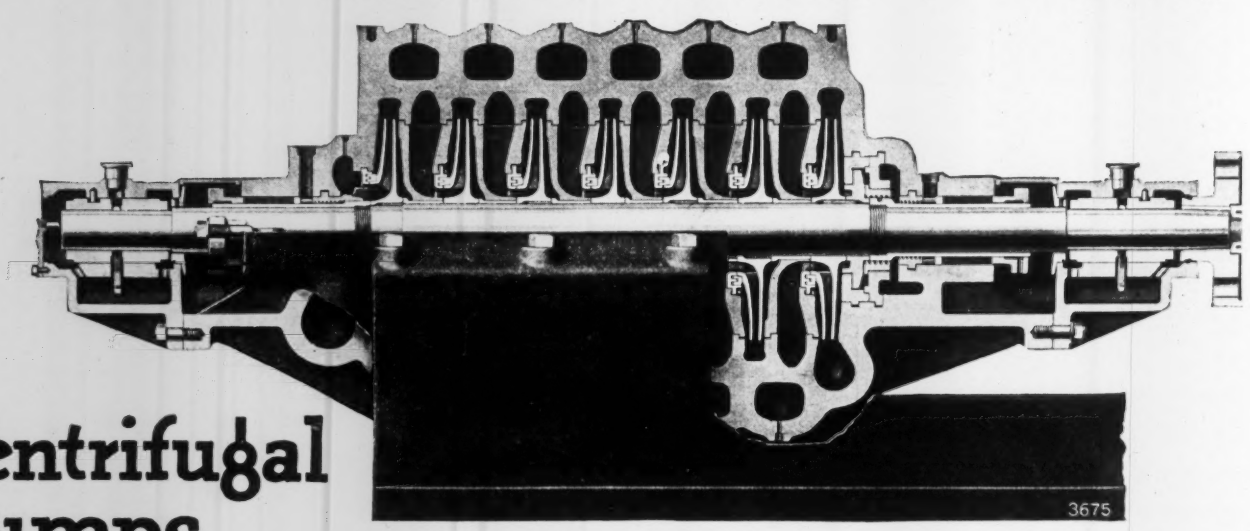
SPRINGFIELD BOILER CO.

SPRINGFIELD, ILLINOIS

OFFICES:
Chicago
New York
Boston

SPRINGFIELD BOILERS

OFFICES:
Pittsburgh
Kansas City
Cincinnati
Minneapolis



Centrifugal Pumps *for* HIGH PRESSURES

THE outstanding success of DE LAVAL centrifugal pumps for high pressures is due to a number of special features, one of the most valuable being:

1—The labyrinth wearing rings. These permit large radial clearance, thereby avoiding chance of seizure and rapid wear, while, at the same time, reducing leakage to a minimum. This joint between impeller and casing is where the greatest wear occurs in a centrifugal pump, and such wear affects the efficiency materially, De Laval labyrinth rings wear much less rapidly than do flat rings and can readily be renewed.

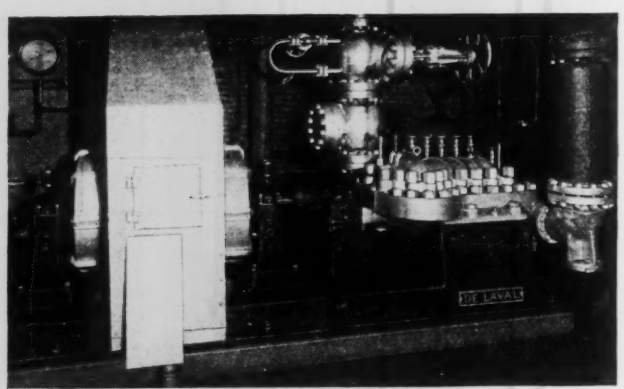
Other distinguishing features are:

2—Solid diaphragms, which prevent blowing out of gaskets and interstage casing leakage,

3—A hydraulic balancing system, which neutralizes axial thrust perfectly, and

4—For high suction pressures and high temperature liquids (as in boiler feeding), a system of **labyrinth rings for breaking down the suction pressure,** with the use of cool sealing liquid, so that high pressures and temperatures do not reach the stuffing box packings.

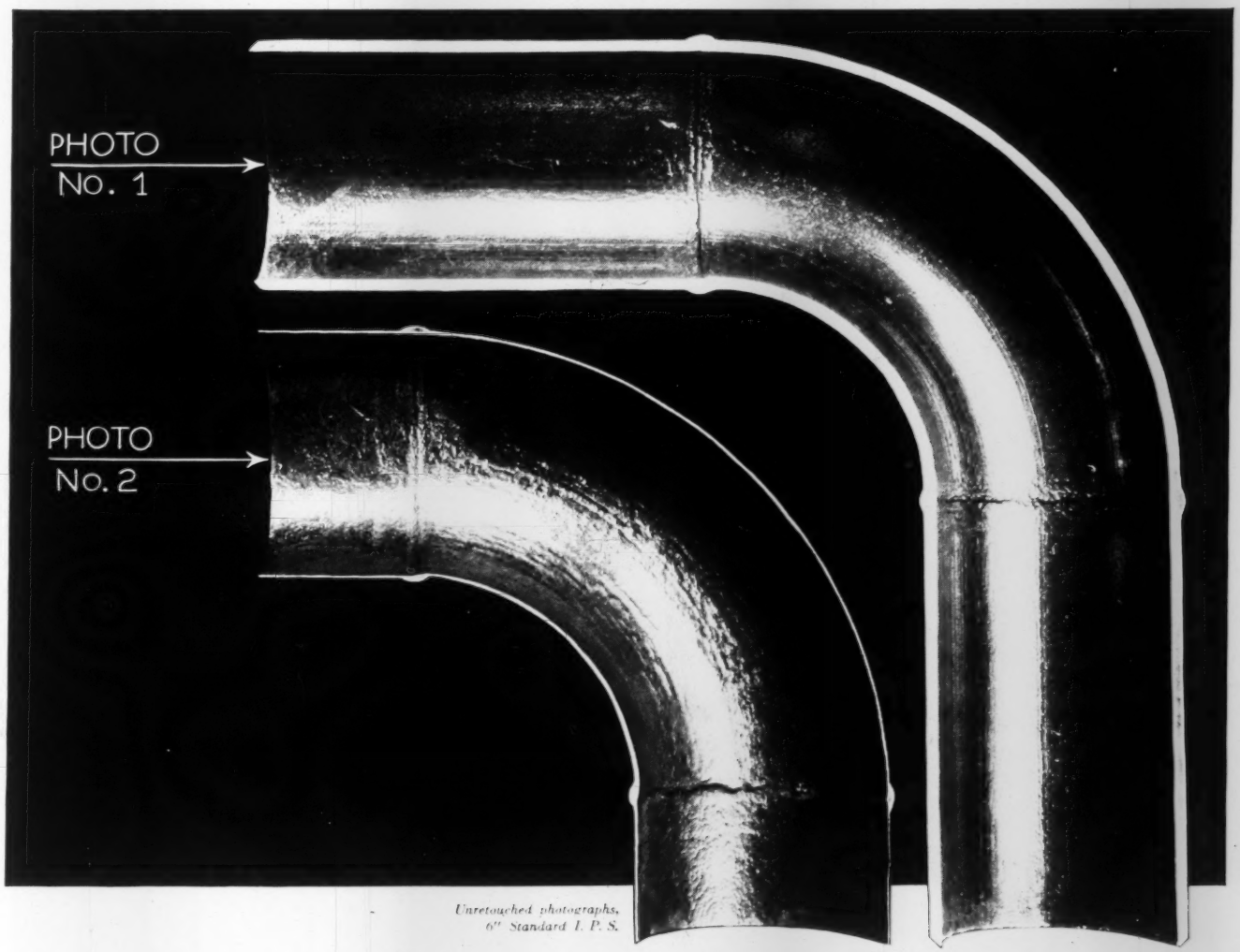
Ask for Catalog B-5.



Six-stage pump delivering 800 g.p.m. against 1600 lb. discharge pressure at 3500 r.p.m.

De Laval Steam Turbine Co.
Trenton, New Jersey

3139



Unretouched photographs, 6" Standard I. P. S.

IF WALLS COULD TALK!

PHOTOGRAPH No. 2 above is a 6" Tube-Turn 90° welding elbow—a mere shell of its former self, now honorably retired after notable service carrying corrosive, high-velocity refinery vapors.

The *inside* wall of the Tube-Turn lost 61% of its original .280" thickness. The *outside* wall lost 77%!

The *outside* wall lost 20% more than the inside wall!

And the pipe lost more than ANY part of the Tube-Turn!

Contrast Photo No. 2 with Photo No. 1—an exact duplicate of the original No. 2 unit! Look at the welds—still stronger than either the pipe or the elbow.

What would have happened if:

35% of the original wall thickness had been cut away at the start by threading the pipe for a screwed elbow?

Or if:

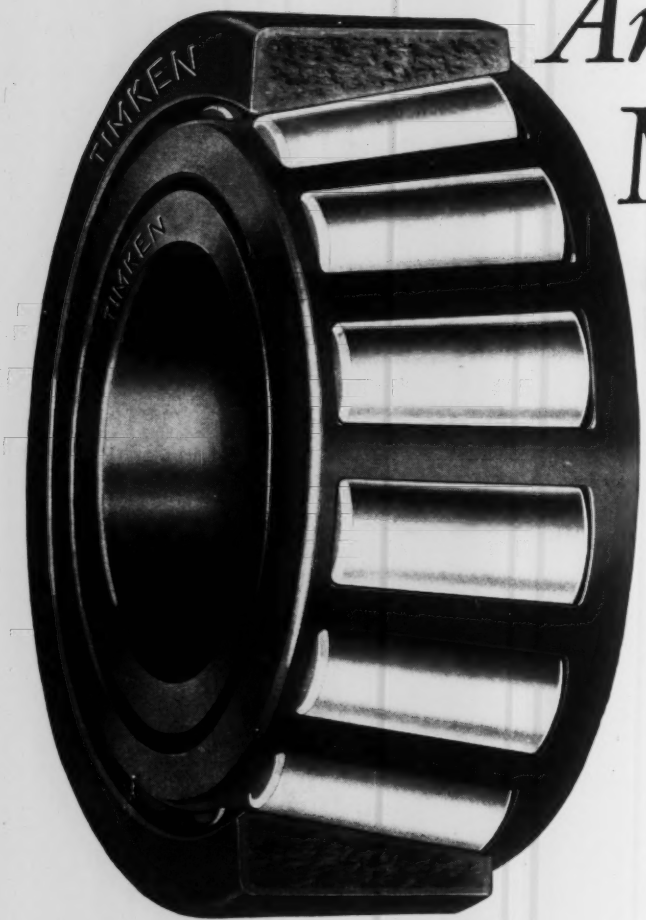
The elbow had been a hot or cold bend, with its inside wall thickened, and with a consequent thinning of the outside wall!

Easy to see why engineers insist upon *genuine* TUBE-TURNS, with their full thickness on *both* the inside and the outside walls! Easy to see why users of welded piping want the name TUBE-TURN (which applies *only* to the fittings manufactured by TUBE-TURNS, *Incorporated*) on their elbows. It guarantees uniformity of walls—*always*, and at *all* points.

In other words, *there's no uncertainty about Tube-Turns. . . .* Write for all the facts. *Address:* Tube-Turns, *Incorporated*, 1303 Shelby Street, Louisville, Kentucky.

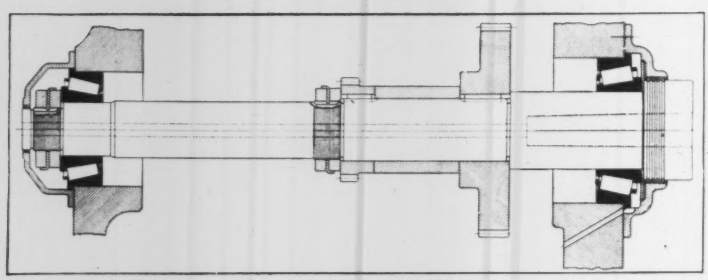
TUBE-TURNS

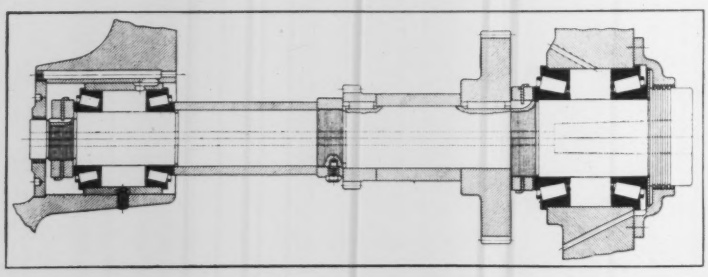
Along Came TIMKEN *to Anti-frictionize* Machine Tool SPINDLES



Today it is as hard to find a heavy duty machine tool spindle *not* on Timkens as it was a few years ago to find one *with* Timkens. The rapid sweep of Timkens to almost exclusive use on spindles is one of the spectacular developments of the industry.

Responsible for such unanimous choice is the exclusive Timken combination of tapered construction, positively aligned rolls and Timken-made, special alloy steel. These qualities give spindles maximum rigidity, freedom from chatter, absolute accuracy, safe preloading, and lasting endurance. This explains why Timken Bearings are so dominantly used on spindles ---why you want them on every spindle in your plant. The Timken Roller Bearing Co., Canton, Ohio.





TIMKEN *Tapered Roller* **BEARINGS**